VOLUME LVII NUMBER 7 WHOLE 504

SCHOOL SCIENCE AND MATHEMATICS

OCTOBER 1957

School Science and Mathematics

A Journal for All Science and Mathematics Teachers

All matter for publication, including books for review, should be addressed to the editor. Payments and all matter relating to subscriptions, change of address, etc. should be sent to the business manager.

Entered as second class matter December 8, 1932, at Menasha, Wisconsin, under the Act of March 3, 1879. Additional entry at Oak Park, Illinois, January 18, 1957. Published Monthly except July, August and September at 450 Ahnaip St., Menasha, Wis. PRICE: Four dollars and fifty cents a year; foreign countries $5.00; current single copies 75 cents.

Contents of previous issues may be found in the Educational Index to Periodicals.

Copyright 1957, by the Central Association of Science and Mathematics Teachers, Inc.
Printed in the United States of America

GEORGE G. MALLINSON
Editor
535 Kendall Ave.,
Kalamazoo, Mich.

JACQUELINE MALLINSON
Assistant Editor
Kalamazoo, Mich.

RAY C. SOLIDAY
Business Manager
Box 408, Oak Park, Ill.

DEPARTMENTAL EDITORS

BIOLOGY—Paul E. Kambly
University of Oregon, Eugene, Ore.

Nelson L. Lowry
Arlington Heights High School, Arlington Heights, Ill.

CHEMISTRY—Gerald Osborn
Western Michigan University, Kalamazoo, Mich.

CONSERVATION—Howard H. Michaud
Purdue University, Lafayette, Ind.

ELEMENTARY SCIENCE—Milton O. Pella
The University of Wisconsin, Madison, Wis.

GENERAL SCIENCE—John D. Woolever
Sarasota Public Schools, Sarasota, Fla.

MATHEMATICS—Cecil B. Read
University of Wichita, Wichita, Kan.

MATHEMATICS PROBLEMS—Margaret F. Willerding
San Diego State College, San Diego, Calif.

NATURE STUDY—E. Laurence Palmer
Cornell University, Ithaca, N.Y. and The American Nature Association.

PHYSICAL SCIENCE—B. Clifford Hendricks
William Woods College, Fulton, Mo.

PHYSICS—E. Wayne Gross
R.R. 6, Bloomington, Ind.

New for the 1957-58 school year—

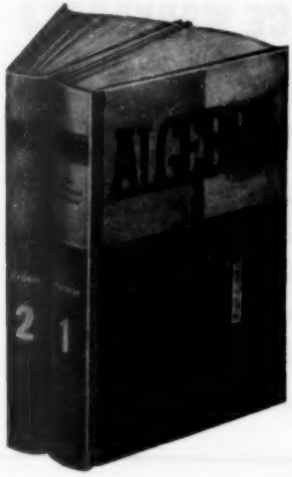
Turtox Biology Catalog No. 59

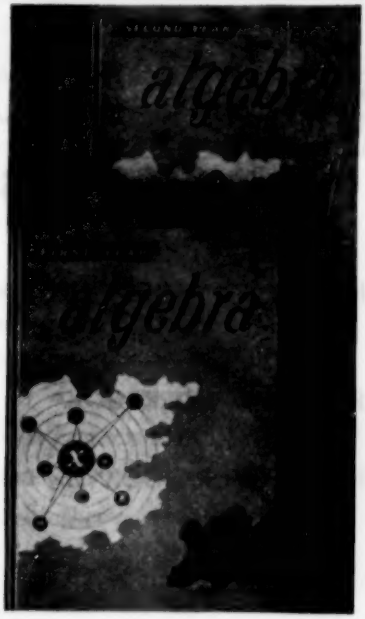
The new and thoroughly revised Turtox Biology Catalog No. 59 was published in August. If you have not received your copy of this 832-page catalog of dependable biological materials, write for it now. Please mention your teaching position and your complete school address.

TURTOX PRODUCTS

GENERAL BIOLOGICAL SUPPLY HOUSE
Incorporated
8200 SOUTH HOYNE AVENUE
CHICAGO 20, ILLINOIS
The Sign of the Turtox Pledges Absolute Satisfaction

Heath offers you TWO outstanding algebra series—





ALGEBRA, COURSE 1 • ALGEBRA, COURSE 2

Fehr, Carnahan, and Beberman

Here content and format combine to make a truly effective series. Features include sound mathematics within the pupils' grasp, emphasis on meaning before techniques, integration of arithmetic with the work in algebra. *Teacher's Manuals, Answers, Tests,* and *Keys* available. (Course 1 of this series has been adopted by USAFI for one of its home study courses.)

FIRST YEAR ALGEBRA • SECOND YEAR ALGEBRA

W. W. Hart, Schult, and Swain

A new modern series with all the time-tested features of the earlier Hart books. You will like the sound approach, the excellent organization of material, the tested instructional methods, the definite procedures. Each book has an attractive and functional format with a variety of devices to make both teaching and learning easier. *Teacher's Manuals, Answers,* and *Keys* available.

D. C. HEATH AND COMPANY

Sales Offices: Englewood, N.J., Chicago 16, San Francisco 5, Atlanta 3, Dallas 1
Home Office: Boston 16

for teaching and learning efficiency - - round out your science courses with

HOLT SCIENCE WORKBOOKS

BIOLOGY INVESTIGATIONS: A Workbook and Laboratory Manual,* by Otto and Blanc

Follows the standard plan of MODERN BIOLOGY

CHEMISTRY WORKBOOK* by Dull and Brooks

Follows the standard plan of MODERN CHEMISTRY

PHYSICS WORKBOOK* by Dull, Metcalfe, and Williams

Follows the standard plan of MODERN PHYSICS

**** Page-referenced for use with any textbook.***

DIRECTED STUDY GUIDE AND MANUAL

a student workbook for use with

—SCIENCE, BOOK 1 (Grade 7)
—SCIENCE, BOOK 2 (Grade 8)
—SCIENCE, BOOK 3 (Grade 9)

A GUIDE TO MODERN HEALTH by Otto and Julian

MODERN PHYSICAL SCIENCE WORKBOOK by Brooks and Tracy

LIVING THINGS WORKBOOK by Fitzpatrick

Tests in equal quantity furnished free of charge with all Holt workbooks in science. Teacher's Edition or Answer Book for all workbooks. Keys for all Tests.

HENRY HOLT AND COMPANY

New York 17 **Chicago 11** **San Francisco 5**

Science is vastly more stimulating to the imagination than are the classics.—HALDANE

CONTENTS FOR OCTOBER, 1957

A Dedication: Dr. and Mrs. Glen W. Warner 507

Highlights of the 1957 Convention Program—*Louis Panush* 509

More Students Taking Science and Mathematics—*John A. Nietz* 512

Are We Trying to Force Mathematical Maturity?—*Sister Mary Jacqueline Perreault, O.P.* 515

Science Progress—*Roy D. Welch, Jr.* 523

Improvement of Mathematics and Science Instruction in New Hampshire —*Roland B. Kimball* 529

Some Suggestions for Unifying High School Physics Around the Concept of Energy—*Kenneth H. Summerer* 536

The Effects of Inserted Questions and Statements on Film Learning— *Jeanette Sprecher Walter, Henry R. Brenner, and Albert K. Kurtz* 541

Physicists Write Books Also—*Sister M. Stephanie* 555

Scope and Sequence of Elementary School Science—*Richard F. Bruns and Alexander Frazier* 560

The Use of the Field Trip in Science—*George Greisen Mallinson* 569

Central Association of Science and Mathematics Teachers 571

Problem Department—*Margaret F. Willerding* 574

Books and Pamphlets Received 580

Book Reviews 582

Here's General Motors' newest educational booklet

"THE STORY of POWER"

an instructional aid

★ 51 PAGES

★ 11 CHAPTERS

★ 71 COLOR ILLUSTRATIONS

Covers the story of power from cave man to atomic man. Gives a full description of the many different kinds of power man has used—and uses today—including jet, nuclear, and solar power.

Quantities are limited. To get your free copy, fill in the coupon and mail it today.

Mail the coupon to:

Educational Relations Section
Public Relations Staff—Dept. 505
General Motors Corporation
Detroit 2, Michigan

Please send me a copy of *The Story of Power*. I plan to use it for the _____ grade. I plan to use it to teach _____.

Name _____

School _____

Address _____

City & State _____

GENERAL MOTORS CORPORATION

Public Relations Staff, Detroit 2, Michigan

NO OTHER Electrostatic Generator Provides ANY Of these Features:

- *Universal* Motor Drive, designed for operation on 110-volt A.C., or 110-volt D.C.
- *Electronic* Safety Valve, to protect the motor against a random high-voltage surge.
- *Removable* Discharge Ball, which the demonstrator may use as a wand.
- *Flat Top* Discharge Terminal (with built-in jack) to receive various electrostatic accessories.
- *Endless* Charge-Carrying Belt, of pure latex, which may be driven at high speed without "bumping."

ALL of the foregoing features are *standard equipment* in CamboscO Genatron No. 61-705.

CAMBOSCO GENATRON 61-705

In addition, CamboscO Genatron No. 61-708 incorporates a built-in speed control, to facilitate demonstrations requiring less than maximum voltage.

The Output, of either model of the CamboscO Genatron, ranges from a guaranteed minimum of 250,000 volts to a maximum, under ideal conditions, of 400,000 volts. Yet, because the current is measured in microamperes, and the discharge duration is a matter of microseconds, no hazard whatever is involved for operator or observer.

- *May we tell you more?*

CAMBOSCO GENATRON 61-708

CAMBOSCO SCIENTIFIC CO.

37 ANTWERP ST. • BRIGHTON STATION

BOSTON, MASS., U.S.A.

A New Physics Text with a New Teaching Approach

BASIC PHYSICS by Alexander Efron, E.E., Ph.D.

These thoroughly readable textbooks (two volumes in one binding) comprise a psychologically organized course in intermediate physics. In its first part (Volume 1) it offers an *overall* view of most of the simpler material of the standard course and in its second part (Volume 2), certain more difficult topics as well as a "deeper look" at those topics which had been previously presented in a purely descriptive and emperical fashion.

Thus, the student is first given a glimpse of the "whole" and *as he gains maturity*, is returned to the consideration of "parts" which he then reassembles into his own, more meaningful pattern. The resulting *spiral* widens gradually until the final approach becomes fully mathematical and analytical. The spiral, of course, never closes since learning is never complete or definitive in nature.

Volume 1 is non-mathematical; Volume 2, mathematical at the intermediate level. Two volumes contemplate a year's course. Volume 1 serving for the first term, Volume 2, the second term.

Special attention has been given to the selection and execution of each illustration. The books are rigorously correct technically, yet generate and maintain interest. Basic demonstration experiments are described and model problems are set up and solved. The historical development of every important physics principle is presented.

The study of both volumes fully satisfies the requirements of the College Board as well as all local, regional and State syllabi. List price $7.60.

ARITHMETIC FOR ENGINEERS (5th Ed. Revised) by Charles B. Clapham

An outstanding text on practical, elementary mathematics for shop machinists, shop mechanic trainees, tool and die maker trainees, mechanical engineering students at the industrial level, mechanical drafting trainees . . . and all others who want to learn the elementary mathematics.

Written for use in schools or home study and industrial upgrading.

Here's what a leading educational magazine says about this book!

". . . It is all there. It is clear, concise, easy to follow, and remarkably understandable. Yes, this is true about Clapham's *Arithmetic for Engineers*. The whole field of practical mathematics is explained in such a manner that any student wishing to review his knowledge of mathematics may do so easily and without much lost motion.

The book was not designed as a textbook for a beginner in the field of mathematics. It was designed as a book to be used for a review of all the mathematics that is needed by a student beginning his study of engineering. It is a book that should be introduced to all mathematics majors in high school, and should be on the bookshelf of every student going into the field of engineering. Teachers of mathematics will find it valuable as a reference."

More than 390 numerical examples of solutions fully explained. More than 1,950 problem exercises, with answers. Cloth Bound, 558 pp. 5½ × 8½", illus.
#183 ..... **Only $6.50**

BASIC ELECTRICITY—BASIC ELECTRONICS
by Van Valkenburgh, Nooger & Neville, Inc.

Over 25,000 Navy trainees have already learned Basic Electricity and Basic Electronics this easy "Picture Book" way! Now, for the first time, the basics of Electricity and Electronics as "Learn-by-Pictures" training courses are available to schools. Over 1,700 simple, easy-to-understand drawings actually make up **more than half** the entire material! No other Basic Electricity or Basic Electronics courses in America use this revolutionary illustrative method. Basic Electricity and Basic Electronics already are adopted texts in many schools throughout the nation.

BASIC ELECTRICITY
#169 Soft Cover: 5 volumes, 624 pp. $10.00

#169-H Cloth Bound; all 5 volumes in a single binding $11.50

BASIC ELECTRONICS
#170 Soft Cover: 5 volumes, 550 pp. $10.00

#170-H Cloth Bound: all 5 volumes in a single binding $11.50

Write for Free 1957 Spring-Summer catalog of all Rider Books.
Send for 30-day approval copies—School Discounts Apply.

JOHN F. RIDER PUBLISHER, INC. 116 West 14th Street, New York 11, N. Y.

CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS—OFFICERS FOR 1957

President: Edward Bos, Proviso Township High School, Maywood, Ill.
Vice-President: Louis Panush, Northeastern High School, Detroit, Mich.
Secretary-Historian, Virginia Terhune, Proviso Township High School, Maywood, Ill.
Treasurer-Business Manager: Ray Soliday, Oak Park High School, Oak Park, Ill.

EXECUTIVE COMMITTEE FOR 1957

Edward Bos, President
Louis Panush, Vice President
Charlotte W. Junge, President for 1956, Wayne University, Detroit, Mich.

BOARD OF DIRECTORS FOR 1957

Ex-Officio

Edward Bos, President
Louis Panush, Vice President
Charlotte W. Junge, President for 1956

Terms Expire in 1957

Wayne Gross, Laboratory School, Indiana University, Bloomington, Ind.
Ralph C. Huffer, Beloit College, Beloit, Wis.
Clyde T. McCormick, Illinois State Normal University, Normal, Ill.
Alice Hach, Board of Education, Racine, Wis.

Terms Expire in 1958

Lawrence Conrey, University School, Ann Arbor, Mich.
Sister Mary Evarista, Mercy High School, Chicago, Ill.
Cecil Read, University of Wichita, Wichita, Kan.
F. Lynwood Wren, George Peabody College, Nashville, Tenn.

Terms Expire in 1959

H. Glenn Ayre, Western Illinois State College, Macomb, Ill.
Francis Gourley, LaPorte High School, LaPorte, Ind.
Walter E. Hauswald, Sycamore High School, Sycamore, Ill.
Luther Shetler, Bluffton College, Bluffton, Ohio

EDITOR OF THE YEARBOOK

Luther Shetler, Bluffton College, Bluffton, Ohio

JOURNAL OFFICERS

George G. Mallinson, Editor, 535 Kendall, Kalamazoo, Mich.
Jacqueline Mallinson, Assistant Editor, Kalamazoo, Mich.

SECTION OFFICERS FOR 1957

(Order: Chairman, Vice Chairman, Secretary)

Biology

Lula W. Casemore, Mackenzie High School, Detroit, Mich.
William A. Hill, Community High School, Naperville, Ill.
Morris J. Pumphrey, Arlington Heights High School, Arlington Heights, Ill.

Chemistry

Robert L. Walker, Lyons Township High School and Junior College, LaGrange, Ill.
Arthur Reynolds, Northern High School, Detroit, Mich.
Gerald Alexander, Ball State Teachers College, Muncie, Ind.

Conservation

Marvin Bell, Indiana State Teachers College, Terre Haute, Ind.
Muriel Beuschlein, Chicago Teachers College, Chicago, Ill.
Rex Conyers, University City High School, University City, Mo.

Elementary Mathematics

Elinor B. Flagg, Illinois State Normal University, Normal, Ill.
Sheldon Myers, Educational Testing Service, Princeton, N. J.
Geraldine Kauffman, 4819 Magoun Avenue, East Chicago, Ind.

Elementary Science

Frank O. Youkstetter, Wayne University, Detroit, Mich.
Sister Mary Lorita, St. Xavier College, Chicago, Ill.
Theodore Wallschlaeger, Palmer Elementary School, Chicago, Ill.

General Science

Fred L. Keil, Proviso Township High School, Maywood, Ill.
Sister Mary Ambrosia, Immaculata High School, Detroit, Mich.
Newton G. Sprague, Instruction Center, Indianapolis Public Schools, Indianapolis, Ind.

Mathematics

Hobart Sistler, J. Sterling Morton High School, Cicero, Ill.
Leonard Antel, Adult Education Day School, Detroit, Mich.
Paul Schuette, Wisconsin High School, Madison, Wis.

Physics

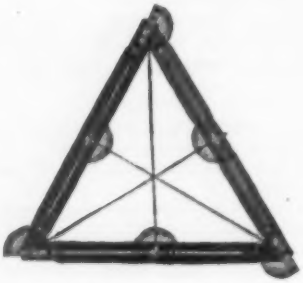
Robert L. Price, Joliet Junior College, Joliet, Ill.
Robert E. Carpenter, Richmond Senior High School, Richmond, Ind.
Paul S. Godwin, Thornton Junior College, Harvey, Ill.

Welch—

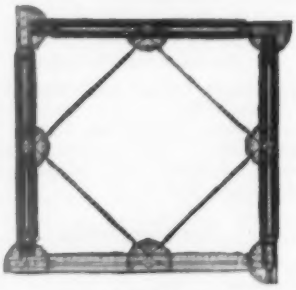
The Schacht Instruments for Dynamic Geometry —as suggested in *Plane Geometry*

by John F. Schacht and R. C. Mc Lennan

Published by Henry Holt and Company



No. 7500
Triangle



No. 7510
Quadrilateral

No. 7545
Circle

Dynamic figures permit observance of continuity and locus concepts as the lengths of sides, interior lines, locations of points and angles are changed. A great variety of figures may be produced to perform many of the exercises of *Plane Geometry* as a laboratory science.

Six of the dynamic instruments are available—adjustable triangle, extensible triangle, extensible quadrilateral, circle, parallel lines and diagonal device. They are accurately and functionally made of anodized aluminum, and will last for years even with hard student use. For further information, please write, or ask your Welch representative about them.

Write for the Welch Mathematics Instruments and Supplies Catalog.

W. M. Welch Scientific Company

DIVISION OF W. M. WELCH MANUFACTURING COMPANY
Established 1880

1515 Sedgwick Street Dept. S Chicago 10, Ill. U.S.A.

Manufacturers of Scientific Instruments and Laboratory Apparatus

SCHOOL SCIENCE AND MATHEMATICS

VOL. LVII | OCTOBER, 1957 | WHOLE NO. 504

A DEDICATION: DR. AND MRS. GLEN W. WARNER

DR. AND MRS. GLEN W. WARNER

On June 30, 1957 Dr. Glen Wones Warner chose to retire as Editor of SCHOOL SCIENCE AND MATHEMATICS. On several previous occasions Dr. Warner had expressed his intention of resigning from the office which he had held since 1926. It is doubtful whether an editor of any similar journal has served so long and with such eminence. During his years of service, many of the tasks associated with the production of the *Journal* were the responsibility of his wife, Alice Koos Warner.

It should be mentioned also that Dr. Warner served the field of education and the CASMT in many ways above and beyond the editorship. Born on October 23, 1883 in a log house four miles northeast of Decatur, Indiana, he attended grade school near, and high school in, Decatur.

His higher education began at Marion Normal College. Later he entered Indiana University with the intention of majoring in political science. However, his interest was quickly diverted to the physical sciences. Hence, in 1913 he graduated from Indiana University with the B.A. in Physics.

He received the M.A. in Education from the University of Chicago in 1919, and the Ph.D. in Physics from Indiana University in 1936.

His work in public education began in the rural schools of Adams County, Indiana. In 1906 he moved to Decatur, Indiana and remained there as high school instructor until 1911. It was during this period on June 2, 1907 that he married Alice Edna Koos. He then served in the schools of Goshen, Indiana from 1913 to 1917. In the school year 1917–18 he was principal of the high school in Globe, Arizona. He then returned to the Midwest to the University of Chicago where he taught for two years while working for the master's degree. From 1920–26 he served as instructor of Physics in Englewood High School, Chicago. Finally in 1926, he accepted the position as teacher of Physics in the Chicago City College which he held until his retirement in 1949.

During his extended tenure in public education he served the CASMT in many capacities. In addition to his editorship, which covered a period of thirty-one years, he was secretary of the CASMT from 1921–24 and a member of the Board of Directors in 1926, 1929, and 1930. In 1931 he was elected President of the CASMT. Finally in 1941 he was made an Honorary Life Member from which time he served more than half his appointment as Editor.

During his present "retirement" he is serving as a member of the Township Advisory Board of Lakeville, Indiana; President of the Farm Bureau; and is a 32nd Degree Mason.

A farewell statement at this time for persons like Dr. and Mrs. Warner, whose activities are not suspended but merely diverted into other channels, would be most inappropriate. It is equally difficult to eulogize these two persons for their services to the CASMT as one would eulogize ordinary people. The usual standards do not apply—the Warners are too big for them.

Hence, with the greatest appreciation to both Dr. and Mrs. Glen W. Warner for their services, the CASMT dedicates to them this October 1957 issue of SCHOOL SCIENCE AND MATHEMATICS.

HIGHLIGHTS OF THE 1957 CONVENTION PROGRAM

2. GENERAL OUTLINE

LOUIS PANUSH

Vice President, CASMT, 3437 Oakman Blvd., Detroit 4, Michigan

In accordance with our policy to keep members and friends of *Central Association of Science and Mathematics Teachers* well informed in advance of the program and activities of the forthcoming 57th annual convention (November 28–30, Congress Hotel, Chicago), we are continuing with an outline of the basic facts and a description of the highlights of the convention program.

1. The convention opens *Thursday evening* with an open meeting of the Board of Directors centered around the theme: "The Future of CASMT? What Are We Working For?" The discussants will be former leaders of the Association, well-known teachers and educators in the field of science and mathematics. Some important problems will be raised: the goals of the Association, what members and attendees expect from an annual convention, how our aims can be implemented and our activities integrated so as to be of value to the teacher in the classroom and to the promotion of a sound and dynamic science and mathematics program in our schools. It is the first time that a Board of Directors meeting will be in the form of an open symposium, and it is hoped that the membership will take full advantage of this opportunity.

2. The first general session on *Friday morning* will be addressed by Dr. Stuart McLain, Associate Director of the Argonne National Laboratory, on "The Nation's Senior Atomic Energy Laboratory—Past, Present, and Future."

(Dr. McLain became associated with ANL in 1949. He was assigned over-all responsibility for the coordination of design for the Materials Testing Reactor at Arco, Idaho, and later worked on the development of data for the Savannah River reactors. He then joined the U. S. Atomic Energy Commission in Washington as Chief of the Production Reactors Branch. He returned to Argonne in 1953, and in 1956 he assumed his present position. His scientific and professional background includes a Ph.D. in Chemical Engineering from the University of Michigan, Chemical Engineer with the U. S. Rubber Company, Assistant Professor at the University of Detroit and at the University of Arkansas, artillery and ammunition development work at Aberdeen Proving Grounds, Head of the Chemical Engineering Department at Wayne University of Detroit, and Associate Director of the Technical Division at the Oak Ridge National Laboratory.)

The address will be followed by a number of experiments and demonstrations in the area of radiation and atomic energy by the staff of ANL. These were especially developed for this program last summer at Argonne to demonstrate principles with readily available equipment.

3. A number of very meaningful and worthwhile activities are offered for *Friday afternoon*. Convention attendees will have the choice of the following:

a. Tour #1 to the *Argonne National Laboratory*. This tour was described in the May issue of SCHOOL SCIENCE AND MATHEMATICS, pp. 382–386. The tour is limited to 200 participants and preregistration and pre-payment will be on a "first-come" basis.

b. Tour #2 to the *Adler Planetarium* for a special program in connection with the International Geophysical Year. From there the group will divide into two sections. One will go to the *Museum of Science and Industry* to see—and hear about—the "World of Numbers." The other will proceed to the *Museum of Natural History* for a special program on the preservation and preparation of plant and animal specimens and displays.

c. A special program will be presented at the hotel for those who prefer to stay in. It will feature:

1) *Demonstrations* by the Illinois Bell Telephone Company on the "Principles and Uses of the Solar Battery" and "Characteristics of Transistors: Newest Advances, Operation, and Uses."

2) *Concurrent symposia* on the theme "What's New in Science and Mathematics: Texts—Equipment—Rooms—Trends?" Well-qualified personnel—educators, authors, and manufacturers—will discuss specific problems in each area.

d. There will be a continuous showing, in the late afternoon, of the *newest available sound films* in color in all areas of science and mathematics on all grade levels. In many cases this will be the first showing. The schedule is so arranged that all groups, including those on the tours, will be able to view some of the films.

4. The evening's general session promises to be a memorable one. The speaker is Professor *Harold C. Urey*. His topic: "Science, Mathematics, and Culture."

(Dr. Urey is the Martin A. Ryerson Distinguished Service Professor of Chemistry at the Enrico Fermi Institute for Nuclear Studies at the University of Chicago. Here he is continuing his research, developing techniques for estimating variations in the earth's climates through the geological ages, and theories to explain the chemical nature of the origin of the universe. It was for his discovery of the heavy isotope of hydrogen, deuterium, that Dr. Urey

received the Nobel Prize in Chemistry in 1934. The same year he received the highest honor in American science, the Willard Gibbs medal. He has been awarded many scientific honors, including honorary doctor of science degrees from Princeton, Montana, Newark, Columbia, Oxford, Washington and Lee, McMaster, and Yale. He was given the Davy Medal of the Royal Society of London in 1940, the Franklin Medal in 1943, Honor Scroll of the Chicago Institute of Chemists and the Cordoza Memorial Award in 1954, the Joseph Priestley Award in 1955, and many others. He has made fundamental contributions to the production of the atomic bomb. As a teacher, Urey is noted for his interest in his students, his close association with their work, and his concern for recognition of their abilities and achievements.)

DR. STUART MCLAIN
Associate Director of the
Argonne National Laboratory

DR. HAROLD C. UREY
Enrico Fermi Institute for Nuclear
Study, University of Chicago

Following the address by Dr. Urey there will be a general reception for which a special program is being planned. Dr. Glen W. Warner, who has made outstanding contributions to CASMT as the editor of its official publications, SCHOOL SCIENCE AND MATHEMATICS, will be honored and given special recognition for his long and distinguished service. Details of this part of the program will be announced later.

5. *Saturday's* program of activities will be another high-spot of the convention. The ***section meetings*** are especially planned to provide almost two hours of professional value and opportunities which will contribute to the teachers' "Expanding Horizons in the Teaching of Science and Mathematics." And, the ***luncheon*** and the ***speaker*** will be worthy as a culminating event of a ***dynamic*** convention. This will be detailed in the next report in the November issue of this Journal.

MORE STUDENTS TAKING SCIENCE AND MATHEMATICS

JOHN A. NIETZ
University of Pittsburgh, Pittsburgh, Pennsylvania

Numerous references in speeches, newspaper editorials, and articles in various journals, have been made to the effect that fewer high-school students are taking courses in science and mathematics than fifty years ago. The bases for most of these references were data taken from the reports of the U. S. Office (Bureau) of Education for 1899–1900 and for 1948–9. Apparently someone took the initiative to look up these data and then others merely copied them, commented on them, and further interpreted them for their own purposes. The writer has seen such references in about a dozen sources. Among the popular writers who commented on them were Benjamin Fine in the *New York Times*, Ansel E. Talbert in his column in the *New York Tribune*, and also Dorothy Thompson in her column in the *Washington Evening News*. Among the speakers using such data, and whose comments were reported in print, were the Chairman of the Atomic Energy Commission in addressing the Sixth Edison Foundation Institute, and the Director of the National Science Foundation in addressing the A.A.A.S. meeting last December. Too, these data appeared in an article written by Douglas Bush in the February (1957) issue of the *Phi Delta Kappan*.

The purpose of this article is to question what appears to be a fallacious use of educational statistics, and as a result to show that proportionately more rather than fewer are taking science and mathematics in high schools today than fifty years ago.

The data most often quoted in the speeches and articles were percentages taken from the 1899–1900 and 1948–9 *Annual Reports* of the Office (Bureau) of Education, which are here reproduced as Table I.

TABLE I

PER CENT OF HIGH SCHOOL STUDENTS TAKING CERTAIN SUBJECTS IN 1899–1900 AND IN 1948–9

	1899–1900	1948–9
Physiology	27.4	1.0
Physics	19.	5.4
Chemistry	7.7	7.6
Algebra	56.3	26.8
Geometry	27.4	12.8

To present a clearer and truer picture of the actual number of

students taking, what are usually referred to as "basic subjects," two additional tables need to be presented.

TABLE II

POPULATION AND PUBLIC HIGH SCHOOL ENROLLMENT IN U.S. IN 1899–1900 AND IN 1948–9

	1899–1900	1948–9
U.S. Population	75,994,575	(About) 148,000,000
Public H.S. Enrollment	519,251	5,399,452

Table II shows, that while the total population less than doubled during the intervening half century, the high school enrollment increased more than ten-fold. In 1900 high school attendance was a very selective matter, while by 1948–9 it had become rather inclusive. During the intervening period the curriculum offerings greatly broadened to meet the needs of the more mixed high-school population. No longer were most students aiming to prepare for college.

A more realistic picture is seen when the actual number of public high-school students taking science and mathematics, as taken from the same reports from which the data for Table I were taken, and the percentage these numbers are of all U. S. youth of high-school age, 14–17 inclusive, in 1899–1900 and in 1948–9, is reviewed. There were approximately 6,123,000 such youths in the U. S. in 1899–1900 and 8,285,000 in 1948–9.

It would seem that there should have been more than eight and a quarter million youth of high-school age in 1948–9 in comparison with over six million in 1900. However, the youth of the latter date were those born during the depression when the birth rate was very low. In fact there were only about half as many born in 1932 as last year (1956).

For both dates the numbers listed as taking these subjects refer only to those in public high schools, since the data usually referred to did the same. Consequently the percentages of youth, 14–17, taking these subjects would be higher for both periods if the students of private secondary schools were included.

The data in Table III show that more rather than fewer were taking science and mathematics in 1948–9 than in 1900, both in numbers and in percentages. More than twice as many are taking physics; three and one-half times as many, algebra and geometry; five times as many, biology; and eight times as many, chemistry. The wrong popular interpretation of the data in Table I is due to the fallacious use of statistics.

Thus whether the data in Table I are used to show that youth of

TABLE III

NUMBERS TAKING SCIENCE AND MATHEMATICS IN PUBLIC HIGH SCHOOLS AND THE PERCENTAGES OF YOUTH, 14–17, TAKING THEM IN 1899–1900 AND 1948–9

	1899–1900		1948–9	
	Enrollment	Per Cent of 14–17 Population	Enrollment	Per Cent of 14–17 Population
			(Plus Biology)	
Physiology	142,401	2.3	1,049,522	12.7
Physics	98,846	1.6	291,473	3.5
Chemistry	40,084	.6	412,401	5.0
Algebra	292,287	4.8	1,448,966	17.5
Geometry	142,235	2.3	693,280	8.4

high school age are not taking science and mathematics, or whether the data are used by those deeply concerned with the subjects vital in relation to national defense, such as the sciences and mathematics. the data of Table III prove the opposite to be true. The writer is a strong advocate both of a sound education and national defense. Nevertheless, the true picture shows that the current high school situation is not so alarming as many speakers and writers would have us believe. It would seem that other types of evidence will need to be presented to prove their contention.

A more recent study made by the U. S. Office of Education reveals that in the fall of 1954 there were 1,293,000 enrolled in tenth-grade biology, 482,700 in eleventh-grade chemistry, and 300,800 in twelfth-grade physics. Thus the enrollments in the sciences continue to rise.

NEW METAL ALLOY MAKES MORE POWERFUL MAGNETS

A new and superior magnetic alloy, called Supermendur, has been developed from iron, cobalt and vanadium, H. L. B. Gould and D. H. Wenny of Bell Telephone Laboratories, Inc., reported in the March issue of the *Journal Electrical Engineering*.

The alloy's exceptional physical and magnetic properties were shown in standard tests where it established six new records for high magnetic characteristics, the engineers reported. It can increase the power output of a transformer coil by 30% and promises to be of value for transformers, high temperature applications, memory devices and telephone receiver diaphragms, they said. Magnetic amplifiers using the alloy can be reduced in size by 20% and still furnish the same output. In high power electronic circuits the new material will, in some cases, reduce the number of amplification stages from two to one, and make further miniaturization possible. The alloy is particularly valuable because it can be cold rolled like other soft magnetic materials into the thin gages that are so vital to modern requirements, the engineers said.

ARE WE TRYING TO FORCE MATHEMATICAL MATURITY?

SISTER MARY JACQUELINE PERREAULT, O.P.
Edgewood College of the Sacred Heart, Madison, Wisconsin

The need to question the validity of our mode of approach to the goal of mathematical maturity is indisputable. We recognize the significance of the question "Are we trying to force mathematical maturity?" To suggest that it can be answered categorically within the confines of any one study is presumptuous. Intensive analyses of children's characteristic levels of performance of basic mathematical processes, however, should make significant contributions. One such analysis follows.

SIGNIFICANCE AND PURPOSES OF THIS STUDY

Current theories in the teaching of mathematics hold that counting and more specifically the idea of grouping through counting, is the base upon which all later achievement in arithmetic rests. They consider the four fundamental processes to be merely short cuts to the manipulation of objects required in the counting of groups. In these theories, great emphasis is placed upon the basic processes of identification of group size and reproduction of groups, and the need for providing children with experiences which include training in performing these tasks without counting.

The methods children use in apprehending numbers as groups have been the subject of a number of research studies. Without a doubt, the most significant are those of Brownell (4) and Carper (2). Color, form, arrangement, and context seem to be important factors influencing method. The relationship between speed of response and method used has been investigated in a recent study by Dawson (3). He concludes that children who respond rapidly tend to group, and children who are slow in responding tend to count. In order to test assumptions regarding level of maturity of operation and to determine the effects of mental age and intelligence factors on maturity level, the writer was convinced that intensive study with individual children needed to be undertaken. This report concerns research designed: (1) to make intensive analysis of children's methods of operation in the identification and reproduction of number groups; and (2) to determine the relationship between these levels of maturity and mathematical achievement. Subsidiary problems which were included in this investigation because they are inherent in the level of maturity hypothesis are: (1) What are the effects of the variables of grade level, mental age and/or intelligence level, indi-

vidual differences, number of units, form of units, and arrangement of units in the group on level of maturity in the identification of number groups? (2) What are the effects of the variables of grade level, mental age and/or intelligence level, individual differences, number of units, and context of units (whether concrete, semi-concrete, or semi-abstract) on level of maturity in the reproduction of number groups?

Definition of Terms

In this study group identification is defined as the recognition of the "how many" aspect of a group of objects. Reproduction is considered to be the ability of the individual to react in response to the cardinal aspect of a number group by reproducing it in some way.

A child may approach the problem of identifying group size or one of reproducing a group in a number of different ways: (1) he may count each individual item; (2) he may recognize a small group within a larger group and count the remainder of the group to get the total; (3) he may count by small groups, as by 2's; (4) he may see the large group as composed of two or more smaller groups and name the total group by adding; (5) he may see the large group as composed of two or more equal groups and multiply to obtain the total; or (6) he may subitize; i.e., recognize the large group instantly without performing any of these processes. Thus there are at least six possible ways of attacking problems of identification and reproduction of groups, which may in turn be arbitrarily defined as representing different levels of understanding and performance. These levels are:

1. counting
2. partial counting
3. group counting
4. grouping
5. multiplication
6. subitizing

The Hypotheses Explored

The design of this study and the nature of the data gathered made it possible to test the following hypotheses:

1. Elementary school children perform the processes of identifying and reproducing groups in a variety of ways.
2. Ways in which children perform identification and reproduction of groups represent a continuum from less mature to more mature performance.
3. The level of performance used in identifying groups varies as the nature of the group to be identified is changed.
   a. Size of group affects level of performance in identifying groups.
   b. A group represented through pictures of actual objects is easier to identify than one represented by geometric units.
   c. Groups presented in patterned arrangements are more easily identified than groups of random arrangement.

4. The level of performance used in reproducing groups varies as the nature of the group to be reproduced is changed.
   a. Size of group affects the level of performance in reproducing groups.
   b. The reproduction of groups with concrete objects is easier than the reproduction of groups with semi-concrete and/or semi-abstract representations.
5. The level of performance used in identifying and reproducing groups changes with variations in mental age and/or intelligence levels.
6. There is a significant and positive relationship between levels of maturity in the identification and reproduction of number groups and general mathematical achievement.

Design of the Study

The design of this study included a population of three grades, two, four and six, in a selected private school with a sample of 18 subjects from each grade with stratification of mental age, and 12 subjects from each grade with stratification of intelligence. A third sample without stratification consisted of 36 subjects from each grade.

The instrument developed to investigate, in individual interview, the level of maturity at which these elementary school children characteristically operate in the processes of identification and reproduction of groups consisted of two distinct parts: one for identification and one for reproduction. The former was made up of 32 picture slides, for each of the numbers 3 through 10. Each number group was represented in two forms, geometric and pictorial, and in two arrangements, random and patterned. In other words, the subjects saw the same number four times in combination of form and arrangement.

The geometric form used was the one-half inch black dot; the pictorial form varied. Color was used in the pictorial slides for the purpose of making the number pictures more realistic. The same random arrangement of each number group was used in one geometric and one pictorial slide. The arrangements for the patterned groups were the quadrat, the triangle, the domino, and the hexagon. Each set of two patterned slides for a given number showed the same arrangement. For example, the domino arrangement for the number five was used with black dots for a geometric slide and with horses for a pictorial representation. This control of variables so that each pair of geometric and pictorial test items presented only one different variable, was established to facilitate the study of each variable as a function of the level of maturity of operation.

The order of presentation of the 32 slides in this instrument was so planned that: (1) number groups appeared in random order; (2) no two slides for any one number group appeared in succession; (3) no groups appeared in serial order either in direct or in reverse sequence. The slides were projected on a screen by means of a 35 mm. filmstrip

machine which was equipped with an automatic changer and a Speed-i-o-scope attachment for timing. The time for each exposure was $\frac{1}{5}$ second. The subjects were prepared for the testing in two steps. First, the interviewer visited each class as a whole for the purpose of securing interest and cooperation in "thinking aloud" about number. Then when each child came for the interview the nature of the test was explained briefly while his eyes became accustomed to the dark required for the projection of the slides. Practice slides were used to acquaint the subject with the $\frac{1}{5}$ second time exposure, to indicate the screen area within which all number groups would appear and to make certain the subject understood the testing procedure. Each child was asked to think aloud telling at once what he was seeing and how many there were in the group altogether. The technique was planned so as to avoid forcing the subject into performance at any given level. The flash technique was used to secure, as nearly as possible, the highest level of performance of which the child was capable. If counting, partial counting, or group counting were characteristic methods employed more time was required and the slide was re-exposed for one to three seconds as required. The average time for re-exposure was two seconds as determined by randomly timing large groups on the first day of testing with each grade. The maturity levels of all responses were checked on score sheets and all relevant verbalizations were also recorded.

The instrument designed for testing levels of maturity in the reproduction of number groups consisted of three distinct situations. In the first situation the subject manipulated thirty objects (one inch varicolored wooden cubes) in the reproduction of groups for the numbers 3 through 10. The order in which number groups were called for, randomized in advance, was: 4, 7, 6, 8, 5, 10, 3, and 9. The test items presented in the second situation were four verbal problems each accompanied by illustrations of either geometric or pictorial groups, each to be circled in part as directed by the problem. The subject was given a copy of these illustrated problems, but to obviate the possibility of differences in performance due to reading difficulties, each problem was read orally for the subject. Since each problem included directions for the circling of part of each of the two accompanying illustrations in reproduction groups no additional directions were given.

The third situation in the group reproduction test called for further manipulation of the same wooden blocks used in situation one. This time the subject was asked to take a group of the blocks for each of the numbers 3 through 10 and to show as many ways of breaking it up into two parts as possible. That is to say, each aggregate was reproduced in its component parts rather than as a total group, the

assumption being that this task of reproduction represented a higher order level of difficulty than was called for in either situation one or situation two. The question asked in this situation was:

> If you break a group of 6 (8, 9, 5, 7, 4, 3, 10) blocks into two groups, in how many different ways can you show 6 (8, 9, 5, 7, 4, 3, 10)?

Responses in this situation were recorded in terms of method used and order in which components were reproduced. Just as in the identification test, all relevant remarks and symbolic behavior were recorded. In evaluating responses in terms of maturity the least mature level, counting, was arbitrarily assigned a numerical value of one, and the score for each succeeding level except level 3 was increased by one point. Group counting was scored 2.5, one-half a point higher than partial counting and one-half a point lower than grouping. Thus the highest possible score for any single response was 5.

Analysis of the Data

Three types of analyses were applied to the data in this study. The level of maturity hypothesis was tested by an examination and comparison of the per cent of responses at each of the six defined levels for each of the eight numbers 3 through 10 in the various test situations. This analysis was not, in itself, adequate to the testing of the subsidiary hypotheses concerning the possible factors influencing levels of maturity. In order to accomplish this the technique of analysis of variance was used. This technique made it possible to test simultaneously not only the effects of the several factors on the outcomes but also the effects of all possible combinations of these factors. In addition, Chi-square technique was used to determine the significance of the difference in the distribution of choices in order of perfomance in the third situation of the reproduction test. In making these analyses, the hypotheses were restated as null hypotheses.

Since the population included in this study had not been drawn randomly from a common population, homogeneity of variance could not be assumed. Therefore, Bartlett's test for homogeneity (4) was applied to the data for each of the samples. In every case the χ^2 obtained was not significant at the one per cent level. Therefore, the hypothesis of homogeneity of variance between groups was accepted and the conclusion made that any significant value of F (significance at the one per cent level alone being considered) was the result of differences in the means of the samples.

For the purposes of this study, the general mathematical achievement of each child was defined as the score made on the California Arithmetic Test, Form DD (5). The primary form of this test was

administered to the second-grade subjects and the intermediate form to the subjects in grades four and six. The results of this test can be tabulated in terms of arithmetic computation, arithmetic reasoning, and total arithmetic achievement permitted the investigation of the relationship of the subscores to the level of maturity scores secured in the identification and the reproduction tests. To supplement the findings of the analysis of variance analyses, the writer also investigated the correlation of mental ages with levels of maturity scores. The Pearson product-moment method (6) of correlation was applied to the raw scores; in determining correlations, the scores for each grade were treated separately.

Limitations of the Study

There were within this study certain limitations. The population was restricted to three specific grades within one school. Although such a population permitted a more intensive exploration of the hypotheses, which was the investigator's major intent, the generalizations which are to be drawn from the study may not be applied to any other than this restricted population. Another limitation was inherent in the test in Situation Two. A sample problem and group should have been provided to enable the subject to familiarize himself with the task to be done before any scores were kept. Improved flash techniques, which have been made available since the writer gathered her data, would serve to eliminate the effect of the after-picture which may have been a limiting factor in this study. In two specific instances, the pictorial form used seemed to lower the level of maturity of response.

General Conclusions

It would be impossible in a report of this nature to give a complete analysis of the data for each grade. Anyone interested in such detail may refer to the study. All we shall consider here are general conclusions. The several analyses made seem to permit certain generalizations which tend to give support to the acceptance of the major hypotheses of the study. These generalizations are:

1. There are six ways in which these elementary school children perform the processes of identifying and reproducing number groups. These ways are: (1) counting, (2) partial counting, (3) group counting, (4) grouping, (5) multiplication, and (6) subitizing.
2. Strictly speaking these methods do not appear to be sequential stages through which all the children passed in the development of the skill of apprehending and reproducing groups as wholes. It appears logical to conclude, however, that three of the methods may represent developmental stages; counting, grouping, and subitizing are modes of attack characteristic of all the children who were interviewed in this study. These three methods represent a continuum from less mature to more mature performance.

a. In identifying groups it may be said: (1) the second-grade children subitized on three, grouped on four and five, and counted all other numbers; (2) the sixth-grade children subitized on numbers three through five and grouped all other numbers.
b. In reproducing groups the predominant methods used by the subjects were subitizing on three and grouping on all other numbers.
c. Partial counting appeared so rarely as to be practically non-existent.
d. Group counting did not achieve a position of dominance in the patterns of methods used by these children.
e. Multiplication appeared to be used more by the fourth-grade population.

3. The levels of performance used in identifying groups varied as the nature of the number group was changed.
   a. The number size of the group to be identified was found to be a significant factor affecting levels of maturity at all grade levels. In general, the level of maturity decreased as group size increased.
   b. Very little variation was observed in the level of response as a result of variations in the form of the objects used in the representations.
   c. The arrangements of the objects in the group appeared to make significant differences in levels of performance. With increase in number size a more rapid decrease in mean scores was observed for random arrangements.
4. The levels of performance used in reproducing groups varied as the nature of the group to be reproduced was changed.
   a. The maturity of method used appeared to decrease with increase in group size. However, the differences in performance were not found to be significant except at the primary grade level.
   b. The reproduction of groups with concrete objects appeared to be easier than the reproduction of groups with pictorial representations.
5. Variations in mental age levels appear to make no significant differences in levels of maturity of performance in identifying and reproducing number groups.
6. Variations in intelligence levels as tested in this study significantly affected levels of maturity of performance.
7. The relationship of levels of maturity in identifying and reproducing number groups to mathematical achievement as tested in this study was found to be positive but low, and in general, not significant. Some significance was established at the lower grade levels.
8. In separating groups into component parts doubles or near doubles tend to be easier to recall than components which are more varied in size.

Implications for Education

This study has certain implications for teachers of elementary-school arithmetic. Since the findings tend to support six levels of maturity but indicate that there is a continuum with respect to only three of them, it might be that some children would be benefited by more gradual induction into the more mature levels of operation. The failure of the subjects investigated to make extensive use of partial counting and group counting might well be attributed to lack of experience with these modes of performance. Classroom teachers could provide a more gradual approach to mature performance through carefully planned programs which emphasize mature counting as a readiness step.

The findings of this investigation tend to support the theories re-

garding the relationship between level of maturity in identification and reproduction and general mathematical achievement. That is to say, a higher level of maturity of operation would probably result in higher mathematical performance. If such is the case, teachers of all grades should provide children with the opportunity to develop the ability to apprehend and reproduce groups at more mature levels. The findings of this study indicating low relationship at the upper grade level may further imply the need to develop mature counting and grouping concepts beyond the grade levels where emphasis on them has been the custom. It is reasonable to propose that greater insight into the nature of the number system would result from more mature approaches to counting and grouping with higher decade numbers, fractions, decimals and/or per cents.

An instrument similar to the one developed in this study might well be used for diagnostic purposes as well as for classroom practice and remedial instruction. Further refinement of the instrument to include higher decade groupings, other pictorial forms, and other random and patterned arrangements and higher level abstractions would provide a more valuable instrument for classroom use.

One other implication suggested by the findings of this investigation is the need for teachers, especially those in the primary grades, to provide the child with opportunities for reproducing groups in semi-concrete and/or semi-abstract as well as concrete context.

The major suggestion for further research is inherent in the limitation of this investigation. The need to extend this study to include a randomly selected population which might make possible the extension of the generalizations beyond the one school used in this study is indicated.

A longitudinal study investigating the progressive development of levels of maturity and/or the effects of special training in mature methods of grouping would be a contribution.

Bibliography

(1) Brownell, William A. *Development of Children's Number Ideas.* Supplementary Educational Monograph, No. 35. Chicago: University of Chicago Press, 1928.

(2) Carper, Doris V. *A Study of Some Aspects of Children's Number Knowledge Prior to Instruction.* Unpublished Ph.D. Thesis. Durham, North Carolina: Duke University, 1941.

(3) Dawson, Daniel Turnure. *Number Grouping as a Function of Complexity* Unpublished Ph.D. Thesis. Stanford University, 1953.

(4) Edwards, Allen L. *Experimental Design in Psychological Research.* New York: Rinehart and Co., Inc., 1950.

(5) Tiegs, Ernest W. and Clark, Willis W. *California Arithmetic Tests, Manual.* Los Angeles, California: California Test Bureau, 1950.

(6) Walker, Helen M. *Elementary Statistical Methods.* New York: Henry Holt and Company, 1943.

SCIENCE PROGRESS*

ROY D. WELCH, JR.
Rand McNally & Co., Chicago, Ill.

A few years ago 21 children were playing in a schoolyard located under the massive cliffs along the shore of the island of Hawaii. To their great astonishment they saw the ocean recede for almost half a mile and what had previously been rolling ocean breakers now was rugged ocean bottom. This phenomenon of course attracted their interest and they playfully investigated the new land. Before they became aware of the tidal wave, it had swept down upon them and they all drowned.

Today we are faced with a tidal wave but one of more tremendous proportions. It is a wave which will not only engulf our students, but also our schools and gravely impede the training of our future scientists and mathematicians: the people who make for so much of our science progress. The dimensions of this problem are quite factually and pointedly stated in the Fund for the Advancement of Education booklet entitled "Teachers for Tomorrow." It states that "there exists a sharply accelerated rate of growth in enrollments coupled with a severe shortage of well qualified teachers, a combination which threatens to cause a progressive deterioration of quality in all levels of education over the next two decades."

Unless we can measure the height and breadth of this problem and take immediate steps for its resolution it will be most difficult for us to make the science progress we have such great need for. What is the extent of this problem? *Teachers for Tomorrow* states that in order to maintain the present over-all pupil teacher ratio, schools will have to enlarge their total teaching staff more in the next ten years than in the previous thirty-five; colleges and universities will have to add more teachers in the next fifteen years than in all previous history; and it will be impossible under the present pattern of teacher recruitment and teacher utilization to secure anywhere near enough good teachers for our schools and colleges over the next fifteen years. Furthermore, it will take half of all college graduates over the next ten years to meet our need for teachers and we are getting only 1/5 of all graduates at the present time.

The problem is aggravated by not enough college graduates entering teaching even to replace departing teachers. Furthermore, the output of new high school teachers in important subject areas has declined sharply in 5 years. The decline in the science field excels all of the other fields. For example, the decline in science from 1950 to 1955

* Presented at the General Science Section of the Central Association of Science and Mathematics Teachers, November 23, 1956.

has been 57%, in mathematics 51%. (In the field of Art the decline has been only 12%). This points out the critical shortage of high school science and mathematics teachers that exists. At the present time there is a need for 7,900 of them. We are only obtaining 3,600.

This problem causes erosion of quality in our schools. For example, in 46% of our nation's public schools and high schools, no foreign languages are offered, in 23% of these schools neither physics nor chemistry, and in 24% no geometry. Since 1900 the number of students studying algebra has fallen from 56% to 24%, the number in Chemistry has dropped from 27% to 11%. These declines are not only undermining the quality of education, but also—and importantly so—the making of our future scientists for without these fundamental subjects, the development of scientists is severely impaired.

According to studies made by Admiral Hyman Rickover "the shortage of scientists is more dangerous to the United States than the Red Army's 300 odd divisions—its recent stock pile of A bombs and H bombs, and the Kremlin's propaganda campaign for a co-existence policy. We may say our present situation is dangerous, in a decade it could be disastrous. The U. S. is training fewer than half of the scientists and engineers needed at the present. The future looks even worse. Perhaps the function of education is to educate all children up to the capacity of their ability to think clearly and act impartially. Because the subjects which help them to think are not being taught, our education is suffering grievously."

Admiral Rickover's statement points to this serious and growing problem: The decrease in the number of qualified scientists to meet the critical demand for them. In 1900 one engineer was sufficient for every 250 workers in industry. Today there is a need for 1 engineer for every 50 workers. The United States Bureau of Labor made a study of 200 large companies which showed that most of them are unable to hire enough technical personnel to fill their needs, and that the shortage of trained scientific personnel has definitely curbed their production capabilities.

If we compare our present status with that of Russia, we can bring this problem into even sharper focus. The Soviets are training twice as many engineers and scientists as the United States. Here we are, graduating 500 nuclear scientists per year when the actual need is for 2,000.

How is this possible? The Soviets have a longer school year than we do, a longer school week, and shorter vacations. They work the students harder during school hours. They seek out the gifted students and give them every encouragement to get ahead. They stress physics, chemistry and mathematics. They know the value of scientists, engineers and physicists and are pushing their training. The

United States, on the other hand, has no similar program to select and encourage and train these specialists upon which our future depends.

The Soviet Union is turning out 50,000 college trained engineers annually as compared with 17,000 in the United States, and 20,000 graduates of medical schools—almost 3 times the 7,500 here. The same is true in the fields of physics, chemistry and mathematics—they are way ahead of us. At the present rate, in another 25 years or so, their technological manpower pool will be so far ahead of ours that we will not be able to compete with them for world leadership. Thus we begin to see the dimensions of the tidal wave.

If we ever solve the problem of these critical shortages, we still would have two minor problems to solve—the problems of selectivity and interpretation of scientific facts.

One of the reasons we must be selective is because no mind digests the immense number of scientific facts and data that exists. It is even hard to keep up with the great number of new scientific developments. We must be able to select important ones and emphasize their significance. They should be balanced so our students are not scientifically illiterate in several fields while being highly educated in one or two.

Through proper selectivity of scientific facts we can achieve several of the following results:

1. A better understanding of the scientific method.
2. The obtaining of skills required to solve problems involved in scientific investigations.
3. An understanding and appreciation for what science can do for mankind.
4. The development of an interesting science as a vocation.

But the interpretation of the scientific data is just as important. Today in all of our news media the child perceives science as an instrument of the Devil. He sees its negative effects rather than its positive ones. Since July 16, 1945 when the first atomic bomb was set off in the New Mexico desert, and August 6, 1945 when the first "A" bomb was dropped in Hiroshima, the world has been facing this problem of the interpretation of the purposes of science. Is it to destroy mankind? Is it an instrument to benefit him?

When our school children hear that Russia is threatening us with atomic annihilation and that we have planned mass retaliation, certainly their world becomes filled with similar ideas. They begin to use science in a most negative fashion—just as adults do. A positive interpretation should be taught to counterbalance this. For instance, we should try to teach the positive aspects of nuclear science, its

great benefit to mankind in medicine and in inexpensive power rather than to emphasize its harmful aspects which might well generate in our students an aversion to science in general.

What will the consequence be if we fail to resolve these problems? "Teachers for Tomorrow," states the results will be "a progressive erosion of educational quality at all levels—and this at a time in history when we urgently need better education, not worse.

"Such erosion would be gradual and subtle, less dramatic than poor school buildings but far more serious. The immediate losers would be the children of a whole generation and the ultimate loser all society."

It will not only hurt our capability for national defense but undermine our international position as well. Furthermore, it will do tremendous damage to our industrial progress. It will increase our illiteracy regarding science in this Atomic Age when the need for realistic knowledge of science is mandatory for survival. More seriously perhaps is the effect that it will have on our ability to think critically and constructively. For the knowledge of the scientific method is essential for doing so. Without a scientific background, it would be difficult for the citizen today to make the serious decisions regarding science required of him. He may have to vote on whether to spend billions on nuclear energy, or to add fluorine in drinking water in his community. Many other decisions may be required of him necessitating a scientific background.

What are some of the solutions to these problems? One of the most important ones is quite obviously to raise teachers' salaries. At the present time the general level is far too low, the rate of advancement far too slow and promotion is not based on performance. Even top salaries must be raised. Teachers in big city elementary schools made an average of $4,817.00 a year in 1953, whereas workers in automobile manufacturing industry earned $4,947.00. Professors in large state universities earned about $7,000, whereas railroad engineers in 1953 earned $7,350. Only 9% of our teachers earned over $10,000 in 1949 whereas 41% of all physicians and surgeons earned over $10,000.

One way to raise the salary structure is to raise the prestige and status of teaching in the community. It must be made comparable to other professions in the eyes of the public. There is absolutely no doubt that this is as important if not more so than many other professions that are far more remunerative.

We must be able to hold the teachers we now have. We must be able to get more teachers by attracting more young people into the profession. We must attract college educated adults in our communities, capable women whose home responsibilities have been reduced,

to do part time and full time teaching. The teacher's job must be defined and organized so as to challenge and utilize effectively his interests and abilities.

If our present pattern of teacher recruitment and teacher utilization is inadequate to secure anywhere near enough good teachers for our schools and colleges, we must take important steps to change our present pattern. Mr. Oscar Handlon, Professor of History at Harvard University and Pulitzer Prize winner recently discussed this problem in the *Atlantic Monthly*. He believes that state requirements "were once essential devices to take the power of appointment out of local politics." He urges that these requirements be reduced and that it no longer be necessary for a B.A. graduate to study for 1 or 2 additional years in order to get a teaching certificate. On the college level, he urges that the doctor of philosophy degree no longer be a license to teach on the college level. Teaching skills could be learned during a summer school program or in evening classes.

Another solution is to borrow teachers from industry. This already is being done but the program could be intensified.

Another solution is to make it a definite responsibility of college science departments to train future science teachers. Also, interested students should work in the laboratories of scientific companies during vacations. In this way their interest in science would be stimulated.

Still another solution would be the expanded use of television as a supplement to the classroom. Also, if our most competent teachers taught the most important subjects and spent less time on administrative matters, part time assistants and non-teaching personnel could take over many of their routine duties. In this way, it would be possible to economize on the valuable time of the best and the most proficient teachers.

Another solution lies in how we teach mathematics. A recent study done by George M. Nesselrod of the University of New Hampshire showed that American school children reject mathematics far more than Japanese because American children are taught to treat numbers as abstractions. He deplores children who ridicule other children for giving concrete meanings to numbers by counting on their fingers. The Japanese, he finds, start using the abacus in the fourth grade to develop their number skills. It makes numbers more concrete for them, thereby stimulating their interest in mathematics so lacking in our school population—and yet so important for an understanding of science.

There are further solutions to our problems. A report by the R. D. Jackson Memorial Laboratory in Bar Harbor, Maine, indicates sev-

eral of them. It conducted a study on scientists to determine what factors influenced their entry into the science field. It found that teachers were by far the greatest and most significant influence in the making of scientists and that even grade school teachers played a significant role in the selection of a science vocation. The study also pointed out that parents, physicians and other scientists as well as relatives and friends who are scientifically minded exert a great influence. The survey also showed that such things as chemistry sets, books, bird watching, flowers, having a basement laboratory and being a winner in a science contest also stimulate the young mind in a scientific direction. Furthermore the young scientist is often frequently motivated by religion and puts his efforts into a field that will benefit all mankind.

In conclusion, let me say that to make scientific progress we must successfully deal with the tidal wave that confronts us at the present time. If we can put some of the solutions suggested above to work, we shall make this progress.

If we are able to teach our students the positive uses of science, select and teach them the most significant scientific facts, train them in scientific thinking, and interpret science to them in a realistic yet positive fashion, we shall be able to place more scientists in our society who will be able to develop the existing fields of science for the betterment of mankind. Take for instance one challenging field where the need for scientists is great and where much research still has to be accomplished—rocket propulsion.

Commander C. Truax, United States Navy, states "No material wealth that could conceivably be brought back from another world could ever compare in value with the new knowledge that would result from exploration of the heavenly bodies. The knowledge itself would be insignificant in value compared with the tremendous stimulus that would be injected into our civilization . . . perhaps such a new outside interest would reduce our preoccupation with our own atomic destruction. The reasons for exploring the Universe, therefore, are concerned not so much with man's ability to exist but rather with the fullness of his existence."

I am sure that all of us who are involved in education will agree with Commander Truax that if our work leads to a level of science progress that makes man far more concerned with the fullness of life rather than with his ability to survive, a most worthwhile and purposeful result will be achieved.

IMPROVEMENT OF MATHEMATICS AND SCIENCE INSTRUCTION IN NEW HAMPSHIRE*

ROLAND B. KIMBALL
Director, Secondary School Services, New Hampshire State Department of Education

It has been nearly two years since Admiral Strauss sent everyone's blood pressure skyrocketing by his remarks on mathematics and science education in the public high schools. While our blood pressure in New Hampshire rose just as much as anyone else's, it is now clear that Admiral Strauss' remarks have been a real benefit to us. The charges he made prompted Mr. J. R. McLane, Jr., the Secretary of the Harriet M. Spaulding Charitable Trust, to discuss with Education Commissioner Austin J. McCaffrey the problems we faced in New Hampshire regarding mathematics and science education. In effect the question we were forced to consider was simply this: Is the situation in New Hampshire as bad as the situation portrayed by Admiral Strauss for the whole nation?

Actually, we were unable to answer the question definitely. There was much information which we lacked. On the other hand, there were many things we did know. For example, we knew that every public high school in New Hampshire offered *both* chemistry and physics, although some small schools had to offer these on alternating years. But we also knew there were more teachers of science on substandard credentials than teachers of any other subject. Second on this list were teachers of mathematics. With three times as many teachers holding substandard credentials for mathematics as for the next closest subject, it was clear that we had a problem. We also knew that about one third of our high schools offered only a two or three-year sequence in what we normally consider college preparatory mathematics. Finally, we knew that our enrollments in high-school mathematics and science classes were very similar to the enrollments for the nation as a whole.

This type of information was largely quantitative. It gave us some information regarding the situation in New Hampshire, but we had to turn to other data for information on the qualitative aspects of our program.

Some state-wide testing done in 1953 showed that student performance in the area of general science was satisfactory, but that performance in the general-mathematics area was considerably below national norms. Further testing indicated that arithmetic performance in grades 6 and 8 was comparable to national norms, and

* Based upon a talk given at the Annual Meeting of the National Association of State Directors and Supervisors of Secondary Education, Washington, D. C., February 22, 1957.

thus we had some indication that mathematics instruction at the high-school level was inadequate.

Additional evidence that all was not well came from a detailed follow-up of the graduates of June, 1954 who went on to college. We checked on every New Hampshire high-school graduate who went on to college that year to determine just exactly what courses he took, which ones he passed, and which ones he failed. From this study we learned that during the freshman year of college these students failed 11% of their mathematics courses, 5% of their science and social studies courses, and 4% of their courses in foreign languages and English. Once again the area of mathematics seemed to be our problem area.

Still another dramatic point which indicated the need for immediate action in New Hampshire was the simple fact that the most recent program of studies for mathematics and science issued by the State Department of Education was dated 1931!

The information which we had available was contradictory. Some was favorable, some unfavorable. Yet, when viewed as a whole, there was no question that we had cause for concern. The officials of the Spaulding Charitable Trust encouraged Commissioner McCaffrey to form a committee to study the problem and map plans to solve it, in so far as possible. No specific amount of money was granted to the committee; it was expected to present proposals from time to time, and if these proposals appeared worthwhile the Trust would grant the funds to carry them out.

Simultaneously, the State Department of Education assembled a small committee to prepare an interim curriculum guide for grade 12 mathematics. The reason for this was that many of our high schools were still teaching in the senior year a conventional one-half year of solid geometry and one-half year of trigonometry. There was a widespread feeling that this was not the best approach and that something should be done immediately. The interim guide which was developed within a period of two months recommends approximately one-half year of trigonometry with considerable emphasis given to analytical trigonometry rather than numerical trigonometry. For the other semester we have suggested about four weeks' study of the basic principles of solid geometry, with the rest of the time given to emphasizing topics in advanced algebra. These topics are the sorts of things ordinarily found in the first portion of college algebra—for example, certain work from the theory of equations, inequalities, probability, etc.

However, our major effort has been made, and will continue to be made for some time in the future, by the group which was formed under the impetus of the Spaulding Charitable Trust. This group,

known as the New Hampshire Committee for Mathematics and Science, is operating with four objectives in mind. Our first objective is to complete a thorough study of the present status of mathematics and science education in the high schools in New Hampshire. Our second objective is to find ways to strengthen the *general* mathematics and science background of *all* high school students. The third objective is to strengthen those sequential programs in mathematics and science which are intended to prepare capable boys and girls for professional activity in these areas. And our final objective is to seek ways to improve the quantity and quality of teaching talent in these areas.

Several steps already have been taken which appear to hold considerable promise. First, even though the status study had not been completed, we assumed that some immediate encouragement to get our teachers professionally active would help. Thus, during the summer of 1956 grants of money were made available to forty teachers, twenty in the field of mathematics and twenty in the field of science, to attend one-week institutes. The mathematics teachers attended the mathematics institute held at Williams College in Williamstown, Massachusetts, sponsored by the Association of Teachers of Mathematics in New England. The science teachers attended an institute sponsored by the New England Association of Chemistry Teachers, which was held at the University of New Hampshire in Durham, New Hampshire. This program was highly successful and will be repeated again during the summer of 1957.

The selection procedures used to determine who would attend these institutes may be of some interest. It was our feeling that at least some of these awards should be given to teachers whose service had been outstanding. Yet, we felt that some of these awards should be given to teachers who had not been particularly active in recent years. Thus, a deliberate effort was made to be sure that a few teachers got these awards simply because we wanted to get them back into the "life stream" of the profession. It would appear that this has been successful; we received many comments from teachers indicating that the institute experience was so stimulating that they have every intention of returning to the institute this summer.

In addition to this type of support, we will offer ten scholarships of approximately $500 each for full-time summer study at any approved university during the summer of 1957. Once again we will try to reach a group of teachers somewhat different from those who can receive support from the National Science Foundation, General Electric, Westinghouse, or Shell, and their summer programs. One of our big problems is the relatively large number of persons teaching science who are not science majors and persons teaching mathematics

who are not mathematics majors. Some of the summer study money will be used to encourage these teachers to study the content area of mathematics or science, of which they now have only a limited knowledge. This means that we will support summer study even though it may be undergraduate work and even though it is not part of any organized degree program. Again the emphasis will be upon trying to help those who need the help most, rather than trying to reward those who have done outstanding jobs.

A second activity has been our questionnaire study. This questionnaire has been sent to every single teacher in the state of New Hampshire who has one or more classes in mathematics or science in the junior high-senior high grades. This questionnaire is an extremely lengthy and even tedious one. In spite of this, within four weeks we have had about a 60% return and are now carrying on a follow-up in an effort to build up at least a 75% return before summarizing.

No systematic summary of these questionnaires has yet been made, but we have been examining them as they come in. I would like to share a few of the impressions which we have gained, although it must be recognized that these are simply impressions which may have to be changed some as a systematic summary of the results is developed.

At least three points seem to be clear. First, it appears that we may have enough mathematics and science teachers to meet the mathematics and science teaching needs in New Hampshire. The problem is to get the right teacher at the right place at the right time. For example, we notice that a person whose major is chemistry often may be teaching in a small school situation where, at the very most, he has only two sections of chemistry and possibly just one, so the rest of his day is spent teaching in areas outside of his major field of competence. This indicates that something might be gained by establishing some pilot programs where we could have an itinerant teacher of chemistry serving two or three, or even more, of our high schools, and a second itinerant teacher, perhaps in biology, doing the same thing. Because this type of teacher utilization certainly would be a little more expensive and might have certain other limitations, we hope to develop a pilot project to test whether it is an effective arrangement.

A second point which has become evident as we read these reports pertains to the type of training which the teachers desire. There has been an almost overwhelming request for *content*-oriented training. The feeling among the teachers appears to be that they have adequate opportunities to take courses in general educational methods, in psychology, in public relations, in guidance, etc., but they have en-

countered a serious lack of opportunity to take courses which relate to, let us say, the history of mathematics, or modern algebra, or logic, or statistics. It is also interesting to note that for the most part the types of programs which these people request involve subject matter content which is ordinarily thought of as being at the college undergraduate level. This, of course, poses a problem because many salary scales are tied to having a Master's degree and thus the teacher is under considerable pressure to take only graduate level courses in a degree-type program. We hope to arrange for courses which may be considered Master's degree-type courses for teachers, even though they consist of predominantly undergraduate material.

Whenever teachers requested training which was method-oriented, the usual pattern was to ask for courses which are highly specific. The teachers seem to desire courses which pertain directly to the mathematics or science which they are teaching. These courses should contain information on the construction of certain specialized teaching aids, the use of teaching aids, the conduct of science laboratory exercises, better understanding of industrial applications, and related topics.

A third point we have noted from our questionnaire is that teachers do have definite suggestions as to how the situation can be improved. Of course, one of the most frequently received suggestions is that of raising salaries. In addition, teachers pointed out emphatically that, in their judgment, the elementary school must share some of the blame. There is a general feeling that the teaching of arithmetic and science in the elementary schools often has been uninspiring; they say it lacks the vigor and imagination necessary to encourage continued study of these subjects. The feeling is that children not only fail to learn all of the mathematics and science which they should learn in the elementary grades, but even worse, they seem to learn to dislike these subjects.

Another suggestion which appeared frequently was an urgent request for better scheduling practice. Many a teacher pointed out that the diversity of his work load has made it almost impossible for him to achieve the instructional goals ordinarily considered appropriate for his course. Perhaps the following quotation taken from one teacher's reply will dramatize the situation: "Stop queer mixtures of class and subject assignments such as mine—biology, civics, economic geography, and girls' athletics. I am interested in all these subjects but sometimes get to feeling like a neurotic chameleon."

However, it appears that the one thing which teachers feel would do the most to improve their jobs is not additional training, or additional money, or additional equipment. It is additional time. As we examine questionnaire after questionnaire we find that in one way or

another teachers are saying that in the last analysis the biggest problem which they face is an overload of one sort or another, and that the only way which they can ever hope to do a truly good piece of work in mathematics and science instruction is to have the time for lesson preparations, for working with individuals, for doing a little home study, and for having an opportunity to relax and build up enough energy to move into the job with vigor and enthusiasm.

A detailed analysis of these questionnaires is now being made. Even at this point it is evident that the final results will offer valuable guidance to those interested in improving mathematics and science education.

A final activity which the committee has under way, and one which we believe holds the greatest promise of all, is a recently organized regional in-service study program. We have a full-time director whose major assignment is to make this program of interest and value to every teacher in the state. Preliminary meetings with both mathematics and science teachers have already been held. We approached those meetings with the hope that the regional study groups could be organized on a basis somewhat similar to the Great Books study groups sponsored by the Ford Foundation. We had anticipated encouraging these study groups to examine some of the major curriculum issues which are now being considered and discussed in so many areas. For instance, we had hoped that perhaps one group might study the work of the University of Illinois Committee on School Mathematics, that another might study the recommendations coming from the College Entrance Examination Board's Commission on Mathematics, and possibly another group might examine and discuss the materials and activities of the Physical Science Committee which is centered at M.I.T. After about a year or more of this type of activity we hoped we could pull together a small group of teachers to prepare a new curriculum guide for New Hampshire for mathematics and science, thus replacing the sadly antiquated one which now is the only thing available at the state level.

The initial meetings with the planning committees seem to indicate that our hopes for this type of approach will not be met immediately. The teachers themselves want the regional in-service study program to direct its attention to highly specific matters. They would like to consider things which bear a direct and obvious connection with what they will be doing in the classroom the next day. Thus, they are interested in ways to present certain topics in mathematics and ways to handle certain types of equipment in the science laboratory.

Just how these differences will be reconciled is not yet apparent. It is our belief, however, that we can start at the very point the

teachers have requested, and yet eventually reach the broader point of view which we feel has been represented in our original plans. Only time will tell how successful we are in this effort.

In addition to these activities, our examination of the problems in New Hampshire had led us to formulate a variety of other projects and study programs. There is no point in describing them at this time, but we do have about 15 or 20 proposals which we hope to implement over the coming years, depending upon the extent of assistance we can receive. We have every reason to feel that at least some of these proposals eventually can be taken from the "Talk about" stage to the "do about" stage.

In closing I would like to observe that the fuss and furor which has been generated with respect to mathematics and science education is merely an indication of a more general problem facing public education. Basically, what we seek is quality programs in our schools for all the intellectual disciplines. We are just as concerned that our schools turn out people who will be competent as judges, ministers, statesmen, and composers as we are that there be competent scientists and mathematicians. It may appear at first as if our attention to the problem in New Hampshire has been somewhat lopsided and has been directed only at these technical areas of science and mathematics. Actually, this is not the case, and we have some very optimistic hopes that recent developments will soon put us in a position to offer considerable assistance to both students and teachers to improve programs in many of the other areas of human concern.

Although every reasonable effort will be made to improve mathematics and science education, and we will throw into that effort all of the resources which are made available to us, we will do so recognizing that the last thing in the world that we want is a program which will turn out boys and girls having a "one dimension intellect." The educational effort in New Hampshire will continue to emphasize a balanced, liberal program.

TEST NEW METHOD FOR PREDICTING EARTHQUAKES

A new method that may result in a way of predicting earthquakes will be tested during the International Geophysical Year now in progress.

Using a "linear seismometer," Dr. Hugo Benioff of the California Institute of Technology will measure the accumulation of strain in the earth's crust in the Andes Mountains. Earthquakes occur when the accumulated strain is released.

Only two of the instruments exist. Dr. Benioff will make the measurements with them in sharply contrasting terrain, very high mountains and neighboring lowlands, Huancayo, Peru, and Santiago, Chile.

SOME SUGGESTIONS FOR UNIFYING HIGH SCHOOL PHYSICS AROUND THE CONCEPT OF ENERGY*

KENNETH H. SUMMERER
Flint Junior College, Flint, Michigan

INTRODUCTION

Much publicity has been given in recent years to the fact that enrollments in high-school physics have not been increasing along with total high-school enrollments. In fact, the March 1956 issue of *Physics Today* reported that physics enrollments have been decreasing for the last six decades. This report stated for instance, that in 1895, 23% of all high school students were enrolled in physics and that 95% of the students that graduated that year had taken a course in physics. This becomes rather startling when it is pointed out that in 1952 only 4.3% of all high school students were enrolled in physics and about 21% of that year's graduating class had studied physics.

This low percentage of students enrolled in physics, when viewed along with the well-publicized national problem of the shortage of scientists, makes it necessary to scrutinize the curriculum of high-school physics. It needs examination because there probably has been no other time in the history of our civilization when the science of physics has played as important a role as it does today.

THE CONTROVERSY OVER HIGH SCHOOL PHYSICS

There has been considerable controversy over the part that the physics curriculum itself has played in these decreased enrollments. In 1953 Paul Hurd[1] stated that physics is the most likely subject to be eliminated from the high-school curriculum within the next ten years. He based this prediction on three major conditions. He first called attention to the decrease in physics enrollments as contrasted with the increased or at least constant enrollment of the other high-school sciences. Hurd next cited several committee reports, some of which were connected with this organization, which went back as far as 1894. In essence these committee reports suggested a physics course based on broad principles of science related to the problems of daily living rather than a course to prepare students for college. Hurd further stated that the recommendations made by these committees have not been adopted and the physics courses today are little different from those that were taught fifty years ago. The only noticeable change in physics content has been the addition of a

* Presented at the Physics Section Meeting of the Central Association of Science and Mathematics Teachers, Friday, November 23, 1956, Chicago, Illinois.

[1] Hurd, Paul DeH. "The Case Against High School Physics." SCHOOL SCIENCE AND MATHEMATICS, XLIII (June, 1953), 439–449.

section commonly called "modern physics." This section is usually "tacked" on the end of the book with the result that this material usually is not covered for the lack of time, especially by those teachers who use the textbook as the course outline. The third item that Hurd cited was the change that has occurred in the high school curriculum caused by the appearance of some so-called physical science courses. He believed that these courses offer sufficient science for the high-school student. These three conditions prompted Hurd to say that physics has lost its place as a standard high school subject.

On the other side of this controversy there have appeared several articles supporting the retention of physics in the high-school curriculum. In 1955 Mallinson[2] stated that physics in some form or other should be retained in the school curriculum at every grade level. This article pointed out that there is much material in the physics course that is of value to people other than the genius, the college-bound, the future physicist, or the future physics teacher.

Mallinson referred to a study by Wise,[3] who attempted to determine the major principles of physics, chemistry and geology which are important to the general education of every high school student. Wise reported that of the two hundred seventy principles necessary for such general education, two-thirds were from the field of physics.

Mallinson uses this study to support the fact that in the schools where a general physical science course has been designed for the general education of all students not only the enrollments in physics have actually increased but also, the students coming to physics from physical science courses have been better prepared. He therefore believes that the high-school curriculum has a greater need for physics than ever before and is not cheapened by the inclusion of general-education courses in physical science.

I should point out that in both of these and similar articles, there is one important note of agreement. That agreement stems from the fact that of all high-school courses, physics has remained the most traditional.

The Development of Physics

Looking into the history of physics we see that our early physics was entwined with the philosophic viewpoints of great men such as Pythagoras, Aristotle, and Archimedes. The medieval habit of appeal to reason without considering observable facts, caused by the influence of these men, continued until the seventeenth century. The

[2] Mallinson, George Greisen, "The Role of Physics in the Emerging High School Curriculum." School Science and Mathematics, LV (March 1955), 211–216.

[3] Wise, Harold E., *The Major Principles of Physics, Chemistry and Geology of Importance for General Education*. Circular No. 308–IV, Selected Science Services, Division of Secondary Education, Office of Education, Federal Security Agency. Washington 25, D. C., 1948, Pp. 1–18.

change from medieval thought to orderly, scientific thought was brought about by leaders like Galileo, Kepler, Huygens, and Newton. It was in this century, for example, that the universal law of gravitation was established.

The eighteenth century, sometimes called the materialistic age, saw heat, light, electricity, magnetism and the active agent in oxidation looked upon by many scientists as different forms of matter. For example, "phlogiston" and "caloric" are reminders of this period. It was readily accepted then that "phlogiston" had weight because when wood burned and the residue weighed more than the original substance, the attendant quantitative considerations were ignored. Quantitative considerations were even slower to gain acceptance at the end of the 18th century when Count Rumford's heat experiments disputed the caloric theory as a form of matter.

The nineteenth century saw the many isolated distinct forms of matter reduced to two major concepts. These were the two great principles of the conservation of mass and energy.

A look at the present physics curriculum shows it is built around six areas. These are consistently found to be mechanics, heat, sound, light, electricity, and modern physics. A survey made of twelve textbooks in 1945, by Weaver,[4] showed that approximately one-third of these texts were devoted to mechanics; approximately one-third to heat, sound, and light; and about one-third to electricity and modern physics, with modern physics getting only about 6 to 7% out of that third.

Such course organization built around these major five items reveals that physics has remained traditional. It has consistently adhered to topics that were originally influenced greatly by sensory impressions. Included within the traditional physics organization are many historical and non-functional items. This approach has been used for a hundred years and it seems, therefore, that the organization and content of physics needs to be reexamined. It ought to be examined in terms of concepts that would contribute to the student's understanding of his own behavior. At the same time it should contribute to his understanding of the devices and common phenomena of the environment in which he lives.

There is one great underlying general principle in physics that can serve as the unifying principle for the entire science. That principle is the transformation and conservation of energy resulting from Einstein's work on the theory of relativity and his energy equation of $e = mc^2$ which was published in 1905. In view of the atomic age, for which the way was paved by this principle, it would seem that a

[4] J. F. Weaver, "The Distribution of Emphasis in Ten Physics Tests and in Twelve Physics Textbooks." *Journal of Educational Research*, XXXIX (September, 1945), 42–55.

reorganization of high-school physics might very well be done around the great concept of energy. Under this unifying philosophy the advanced theories of physics can be presented on more elementary levels.

Some Suggestions for Unifying Physics

Using the concept of energy as a unifying device I have thought through some ideas around which a high-school course might be built. These ideas are only suggestions; I have not thoroughly investigated their application.

Energy considerations can simplify many problems in mechanics. For a specific case we might consider a body being moved up an inclined plane. The energy supplied from the outside must equal the energy used to overcome friction plus the change in kinetic and/or potential energy of the body. This energy balance is equally applicable to a charged body in an electrical field. Every such particle has potential electrical energy which comes from the work done in moving it against electrical forces.

Another energy concept around which topics can be built is that all physical occurrences are based on energy transformations. The second part of Newton's first law concerning a body in motion along a straight line can be thought of as an energy transformation. Part or all of the energy of one body was imparted to the second body to produce the straight line motion. The concept of a straight line in this example presents another opportunity for the physics curriculum to be brought up to date. The opportunity is to present Einstein's theory of relativity on an elementary level to describe a reference so the student will have some idea of just what a straight line actually is.

I have presented here just a few of the many possible ways to show that energy of some kind is present in the occurrences around us. Similar examples could be given about the transfer of energy in the operation of a transistor or vacuum tube, magnetic energy, the energy of falling water to be used for electrical power, the energy in transportation, the energy of the stars, and especially the energy of the atom.

Throughout every one of my suggested ideas there is one underlying theme. That theme is man's attempt to develop, control, and use energy to benefit mankind. If we look around us we also see man's concern over energy he has not yet learned to control. He is still learning about energy in the atom. He has not learned enough about the energy of radiation. He has not learned to control or even precisely predict the energy of atmosphere (witness the tornadoes in this country every year).

The implementation of such ideas into a physics curriculum will

require careful thought. Operating on the premise that the course remains rigorous, every item retained for the course should contribute to the central theme of energy. Obviously many items that have been retained over the years for their historical interest will have to be left out. Others, that do not fit directly into the energy concept would have to be eliminated.

For instance, I would question the retention of problems illustrating Charles' and Boyle's Law. When studying electrical energy I would leave out any discussion of the chemical action in a cell. These topics are treated in the chemistry course and, therefore, need not be treated in physics. I would also question the retention of problems involving vectors. This concept can be handled very well in the trigonometry course. Discussions about historical items such as the lift and force pump can be left out because they do not contribute to the concept of energy.

I am sure the omission of some material presently included in the traditional textbook would be welcomed by many teachers. It will be especially welcomed by those who see the need for introducing students to principles that have been formed and facts that have been acquired by modern physicists.

Conclusions

It is reliably estimated that this country's need for energy of all kinds is going to more than double in the next twenty-five years. It is obvious that the more energy man has available, the greater will be his productivity. This productivity in turn will lead to a higher standard of living in the world. For these reasons, I would strongly urge consideration of the concept of energy as a unifying principle in the teaching of physics.

ANNUAL ELECTION

On Friday, November 29, 1957, at the annual business meeting in Chicago, Central Association will elect

For one year: A President and a Vice-President
For three years: Four members of the Board of Directors.

The Nominating Committee is seeking the help of all members of the Association in preparing a list of able and worthy nominees for these important offices. In particular, YOUR ideas are needed.

Please send recommendations to any one of the following members of the Committee: Emilie U. Lepthien, 2230 W. Cortland, Chicago 47; Milton O. Pella, University of Wisconsin, Madison; Stanley Richards, 2235 Scoville, Berwyn, Illinois; Winnafred Shepard, 333 Greer Avenue, White Hall, Illinois; or H. Vernon Price, Chairman, University High School, Iowa City, Iowa.

THE EFFECTS OF INSERTED QUESTIONS AND STATEMENTS ON FILM LEARNING*

JEANETTE SPRECHER WALTER
Springfield, Pennsylvania

HENRY R. BRENNER
The Standard Oil Company (Ohio)

AND

ALBERT K. KURTZ
University of Florida, Gainesville, Florida

SUMMARY

In this experiment, six methods of teaching a body of factual material by films were compared. Two different films were used: One dealt with a technical subject, "The Care and Use of Hand Tools—Wrenches"; the other was of the general information type dealing with "Snakes."

Six versions of each film were prepared as follows:

I. The original film, used as a control version.
II. A repetition version, consisting of two prints of the original film, spliced together, and shown in continuous succession.
III. A "persistent questions" version that had multiple-choice questions inserted as frequently as possible—every 32 seconds on the average.
IV. A "persistent statements" version which contained reinforcing statements at frequent intervals—on the average of 32 seconds.
V. A "medium questions" version which contained only every *alternate* question used in the "persistent questions" version.
VI. A "medium statements" version which contained only every *alternate* statement used in the "persistent statements" version.

The inserted multiple-choice questions were designed to be very simple, always covering information that had just been presented. They were intended to facilitate learning, not to measure the learning which took place. The students were required to answer each question as it appeared on the screen. After a short interval, the correct answer was given and the film continued to the next point. The statements were intended to reinforce the information which immediately preceded them and were inserted at the same places in the film as were the questions in the "questions" versions. They covered the same material.

A total population of 3039 tenth-grade students in seven Pennsylvania high schools participated in the experiment. Of this number, an analysis was made of the test scores of 1332 subjects, comprising 111 boys and 111 girls from each of six of the seven schools.

* This article is based on part of a joint thesis submitted for the degrees of Masters of Science at the Pennsylvania State College where copies of the complete thesis are now on file.

The experimental sample was selected by matching individuals across the six schools for sex, age, and mental ability (as measured by the Otis Quick-Scoring Mental Ability Tests, Gamma Test: Form Bm). Selected samples in all the schools were practically identical with respect to age, sex, and intelligence test scores, the sample in each school being used as an intact group for one version of each of the two films.

The students were first given a typed list of the unfamiliar words which would be mentioned in the films. In the case of the inserted questions versions, they were given verbal instructions about answering the questions in the film on a special answer sheet. The film version was shown and immediately afterwards a multiple-choice item test was administered. The test on the "Wrenches" film contained 71 items; the test on the "Snakes" film included 74. The tests were readministered after a period of four weeks as a means of measuring retention of learning.

The data were analyzed to provide mean scores as follows: (1) for each version of both films, (2) for boys and girls separately, (3) for *all* items in the tests, (4) for those items which were emphasized by "persistent questions" or "statements," (5) for those items emphasized by the medium level of questions and statements, (6) for those items *not* emphasized in the "persistent" versions and (7) for those items *not* emphasized in the "medium" versions.

The repetition version and the inserted questions and statements versions were generally superior to the original film shown once. *Showing the film twice* (repetition version) was about as effective for teaching specific important points as emphasizing these points directly by the insertion of participation questions or reinforcing statements.

The absence of a generally consistent order of effectiveness of the various treatments limits the conclusions that may be drawn. It seems clear that both inserted questions and statements and repetition of the film without inserted material were effective in facilitating learning. Furthermore, showing the film twice—a relatively simple and inexpensive procedure—seems to be about as effective as the more elaborate methods used.

Introduction

This study represents an attempt to assess the relative contribution to learning from films of participation (by immediate audience response to inserted questions on salient facts), of reinforcement (by immediate repetition in titles of salient points of fact), and of showing a film twice.

Other investigations have shown that both participation by means

of response to questions and reinforcement by restatement of main points or by repeated showings may contribute to more effective learning. Hall,[1] using silent films with first-year high school students, employed a slide projector to project questions on a separate, but adjacent, screen before and during the showing of films. He found that learning was facilitated. The Information and Education Division, Army Service Forces,[2] studied the effect of participation in learning the phonetic alphabet from sound filmstrips. In the "standard" version of the filmstrip, the commentator stated both the letter and the phonetic symbol as a review exercise after each symbol presentation. In the "participation" version, review by the commentator was omitted and, instead, the trainees were required to call out the symbol upon being shown the letter. The "participation" version was substantially superior to the "standard" version in percentage of phonetic symbols recalled. Using a similar technique to achieve participation in a film on map signs, Kendler, Cook, and Kendler[3] also obtained positive results. Repetition achieved by multiple presentations of a review following the film's introduction was also found to facilitate learning. Gibson[4] reported that learning to identify aircraft from slide films was facilitated by requiring attempts in recalling identification as early as the second exposure of the slide, followed almost immediately by repeating the correct identification.

An experiment rather similar to the one about to be reported was carried out by the Motion Picture Research Project of Yale University.[5] That investigation studied the value of introducing into a film a number of questions designed to increase the pupils' motivation to learn and to increase their active participation as they viewed the film.

Pictorial material from two already existing films, on the subject of the heart and the circulation of the blood, was organized into a series of seven units. The *motivating questions* were presented in titles just before each unit of factual material. The questions were designed to interest the pupils in learning the material about to be presented, and to direct attention to the relevant aspects of what was to be shown. The *participating questions* were designed to get the pupils to respond

[1] Hall, W. J. "A Study of Three Methods of Teaching Science with Classroom Films," SCHOOL SCIENCE AND MATHEMATICS, 36, pp. 968–973, December, 1936.

[2] Information and Education Division. "Value of an Audience Participation Technique in Film-Strip Presentation," Headquarters, Army Service Forces, June, 1945, Report No. B-154.

[3] Kendler, T. S.; Cook, J. O.; and Kendler, H. H. "An Investigation of the Interacting Effects of Repetition and Audience Participation on Learning from Training Films," *American Psychologist*, 8, pp. 378–379, August, 1953.

[4] Gibson, J. J. (Editor), *Motion Picture Testing and Research*. Army Air Forces Aviation Psychology Program Research Reports, 1947, Report Number 7.

[5] Motion Picture Research Project, Yale University. "Do 'Motivation' and 'Participation' Questions Increase Learning?" *Educational Screen*, 26, 256–259, 274, and 283, May, 1947.

actively by answering, at the end of each unit, a question concerning the material that had just been presented. The questions were printed on a work sheet which the pupils used during the film showing. As each unit was completed, a film title directed the pupils to answer the question covering that unit. After a short interval, the correct answer was then given on the screen.

Approximately 600 tenth- and eleventh-grade pupils, divided into five groups, were used. They were matched on the basis of school grade, initial test score, and sex. Each group saw a different version of the film. The five versions were: (1) a straight factual presentation with neither motivating nor participation questions; (2) the factual presentation supplemented by participation questions; (3) the factual presentation supplemented by motivating questions; (4) the factual presentation supplemented by both motivating and participation questions; and (5) the factual presentation shown two times with neither motivating nor participation questions.

All other versions were superior to version I. The amounts of superiority, as measured by difference in average gain over pretest in percent of correct answers, were: 4% for version II; 2% for version III; 6% for version IV; and 4% for version V.

That study raised an important question concerning what material was affected by the participation questions. It is possible that the insertion of questions may reinforce learning of the facts dealt with in these questions, but interfere with learning of other facts in the film. Scores on items relating to points emphasized by participation questions were analyzed separately from scores on items relating to non-emphasized points. A comparison between the straight factual version and the participation questions version showed that superiority on total score for the group seeing the latter version was almost entirely attributable to superior performance on test items relating to the specific points emphasized by participation questions.

Statement of the Problem

In the present study the following questions were posed for experimental investigation:

1. What is the effectiveness of a particular type of *overt* action on film learning? The method used was that of inserting a certain number of multiple-choice *questions* in an educational film. Each question was read by the commentator as it appeared on the screen. The student marked his answer on the answer sheet. The correct answer was then shown on the screen, repeated by the commentator, then the film subject matter continued until the next question appeared.

2. What is the effectiveness of including some other type of relevant material not calling for the use of overt activity? The method

used was that of inserting a certain number of *statements* in the film, so that the students would see and hear the statements covering the factual information which had just been presented in the film. These statements were read by the commentator as they appeared on the screen, and were positive reiterations of the points which were reinforced in the other film versions by the inserted questions.

3. Which of two levels of rates of occurrence of inserted questions or statements would produce more learning? The higher level consisted of twice as many questions or statements as the lower level.

4. A fourth question was to determine whether or not a difference in film subject matter would influence the relative effectiveness of inserted questions or statements. The method used was that of varying the type of subject matter by using two types of films, a technical film and a general information film.

5. Does the effectiveness of inserted questions or statements vary with the sex of the film audience? The method used was that of analyzing the test results of the boys and girls separately.

6. What is the effect of inserted questions or statements on the *retention* of the film subject matter? The method used was that of administering a retention test four weeks after the showing of the film.

7. Is showing a film *twice* a good method of increasing learning? The method used was that of showing the original unaltered film two times in immediate succession. This permitted comparisons with the original film shown once and with the special versions containing inserted questions or statements. This arrangement also made it possible to equate for the time required by the special experimental versions.

Experimental Design and Procedures

The Films

Two films differing in subject matter were selected for use in the experiment. They were "The Care and Use of Hand Tools—Wrenches"[6] and "Snakes."[7]

For each film, six versions were prepared as follows:

C1—the base film, used as a control version.

C2—a repetition version, two prints of the base film spliced together and projected in continuous succession.

PQ—a "persistent questions" version that had multiple-choice questions inserted at a "persistent" level—every 32 seconds, on the average.

---

[6] Produced by the U. S. Signal Corps. Black and white, sound film. The original film was edited and shortened to 13½ minutes, and a new commentary added, with appropriate changes made for each version.

[7] Produced by Coronet. Color, sound, running time of 10½ minutes.

PS—a "persistent statements" version that had reinforcing statements inserted about every 32 seconds.

MQ—a "medium questions" version that included only half the questions from the "persistent questions" version, or a question every 64 seconds, on the average.

MS—a "medium statements" version that included only half of the statements from the "persistent statements" version, or a statement about every 64 seconds.

The inserted multiple-choice questions were designed to be very simple. They always covered information that had just been presented. They were intended to facilitate learning; they were not used to measure the learning that took place at the time.

In the "persistent questions" version, as many questions were inserted as possible, within the limitation that the intervals between questions be kept approximately equal. To achieve a smooth production, questions were inserted at places where there was either a fade-out or a change of scene, either of which was accompanied by a pause in the commentary. In the "persistent" version of "Wrenches," there were 25 questions; in the "persistent" version of "Snakes" there were 20.

Since the "medium questions" versions were prepared by deleting every even-numbered question from the "persistent questions" versions, there were 13 questions in the "medium questions" version of "Wrenches" and 10 questions in the "medium questions" version of "Snakes."

The inserted statements in the "statements" versions were inserted at the same places and covered the same points which were the subject of questions in the "questions" versions. For example, in the "questions" versions of the "Snakes" film the following question occurs:

> Special organs in the mouths of snakes combine the senses of:
>
> (1) hearing and smell
> (2) sight and hearing
> (3) taste and hearing
> (4) taste and smell

The corresponding statement was:

> Special organs in the mouths of snakes combine the senses of taste and smell.

The Tests

Matching test. To select comparable groups of students, the Otis Quick-Scoring Mental Ability Tests, Gamma Test: Form Bm, was employed.

Film tests. A multiple-choice test was constructed to evaluate the

learning from each of the two films. The test on "Wrenches" included 71 items; the test on "Snakes" included 74 items.[8]

Questions were written covering some of the material which was emphasized in the four films with inserted questions or statements. Such items were called *emphasized items*. Other items were called *unemphasized items*. The following scores were obtained for each film test: total score, score on emphasized items, and score on unemphasized items. These scores were obtained for the boys and girls separately, as well as for the two groups together.

Experimental Population

A total population of 3039 tenth-grade students in seven Pennsylvania high schools participated in the experiment. Of this number, an analysis was made of the film test scores of a sample of 1332 subjects, comprising 111 boys and 111 girls from each of six of the seven high schools.

The experimental sample was selected by matching individuals across the six schools, for boys and girls separately, on the basis of their intelligence test scores. In selecting each set of six students, if several with identical scores were available in one school, the choice was made so as to minimize the age range. If a choice was still possible, it was made on the basis of a vocabulary score based on 18 of the intelligence test items. This matching was done *after* the films had been shown and the film tests administered to the 3039 students, so that it was possible to exclude any individual who had failed to be present at all the film and test sessions.

As a result of the matching, 76 girls were matched from each of the six schools by identical intelligence test scores, and 35 more from each school were matched within a 3-point intelligence test score range. Similarly, 62 sets of boys were matched exactly, and 49 more sets were each matched within a 3-point intelligence test score range.

The mean intelligence test score for each set of boys was 38.3 with a standard deviation of 8.7; the mean intelligence test score for girls was 35.5 with a standard deviation of 8.4.

Experimental Procedures

Since the sample in any one school was practically identical, with respect to intelligence test score and age, to the sample in any other school, the sample in each school was used as an intact group for one version of each of the two films. However, in no school was the same version of both films shown. Table I summarizes the distribution of versions by schools.

[8] The reliability coefficient, based on Kuder-Richardson Formula (14), for "Wrenches" was .92 and for "Snakes," .90.

TABLE I

DISTRIBUTION OF FILM VERSIONS BY SCHOOLS

School	"Wrenches" Film	"Snakes" Film
A	Base Film Once Only (C1)	Base Film Twice (C2)
B	Base Film Twice (C2)	Medium Statements (MS)
C	Persistent Questions (PQ)	Persistent Statements (PS)
D	Persistent Statements (PS)	Medium Questions (MQ)
E	Medium Questions (MQ)	Base Film Once Only (C1)
F	Medium Statements (MS)	Persistent Questions (PQ)

The experiment in each school was conducted in the school auditorium. Teachers served as proctors, with one teacher for approximately 30 students.

After the students were seated, a short standard motivating introduction was given them. Then a list containing the more difficult words in the "Wrenches" film was read aloud. This list, which was also mimeographed on the back of the IBM answer sheets, was used to enable students to recognize in written form those unfamiliar words (such as ratchet, slot, socket, and torque) that they would hear in the commentary in spoken form.

After the word list had been read, the "Wrenches" film was projected. In order that students who were to be shown the "questions" versions could see to write during the film showing, the auditoriums were dimly illuminated for *all* versions, to obviate a differential effect attributable to this illumination.

For the "questions" versions, the projected questions were answered on special answer sheets during the showing of the film. Each student wrote the number of the answer which he thought was correct in a column headed "Your Answer". The students were allowed eight seconds to answer the question. The incorrect alternatives on the screen "faded away", leaving only the original question, the number of the correct answer, and the correct answer. At that time, the commentator repeated this information. The students then wrote the number of the correct answer in the column headed "Correct Answer" on the special answer sheet.

These special answer sheets were not collected or graded. The subjects were informed that these papers were for them to keep. They were also told how they could compute their percentage grades, so they could see how well they did on the questions. It was quite possible for the subjects to wait until the correct answer had appeared on the screen before writing the number. However, from close observation of the students while they were viewing the film, it appeared that they were following the directions implicitly and playing the

game. One reason for this may have been the fact that the questions were very easy.

The "statements" versions required no such participation on the part of the students.

Immediately following the showing of the "Wrenches" film, the film test booklets and IBM answer sheets were distributed. The students were given thirty minutes' working time on each test. Four time warnings, one every seven minutes, were given during the administration of the tests. Both the test on the General Information Film (Snakes) and the test on the Technical Film (Wrenches) were designed to be power tests and not speed tests. For most students, thirty minutes was ample time to complete the tests.

After the test materials on the "Wrenches" film were collected, the entire procedure was repeated for the "Snakes" film: The vocabulary list was read, the film was projected (with interpolated responses to questions if it was a "questions" version), and the film test was administered.

Four weeks after the film showings, the students were again given the two film tests to obtain a measure of retention learning.

Results

In this experiment, six experimental film versions were used for teaching a body of factual material. Since two separate films were used, and since an analysis was made of the performance of boys and girls separately, a large number of comparisons was possible.

The order of the six methods (as their effectiveness was measured by the mean scores on the two film tests) was generally inconsistent as between both the sexes and the two films. Only two relatively consistent relationships (consistent for both films and both sexes) were noted.

First, the repetition version (showing the film twice) was better than the "persistent questions" version, "medium questions" version, and the "medium statements" version. However, the anomalous result that the boys seeing the "Snakes" film *once* scored higher than any other group of boys seeing the "Snakes" film should be noted.

Second, the "persistent statements" version was consistently better than the "medium statements" version (although the "persistent statements" version was not always better than the repetition version).

A constant sex difference was also noted: For every version for both films, the scores of the girls were lower than the scores of the boys. It should be noted that the mean intelligence score for the boys was higher than that for the girls, but this difference was not great enough to account for the difference in performance on the film tests.

The results of the retention tests closely paralleled those for the immediate recall test, except that some forgetting occurred.

Total test score results. Table II summarizes the mean scores on the total test (all items without distinction as to whether they were emphasized by the questions or statements, or not emphasized at all). The means are presented both by schools and by film versions to facilitate evaluation of *inter-school* as well as *inter-method* variability.

TABLE II

MEAN SCORES ON TOTAL FILM TEST, FOR BOTH FILMS, FOR SEXES AND SCHOOLS (IMMEDIATE RECALL TEST)

By Versions

Version	"Wrenches" Film			"Snakes" Film		
	Boys	Girls	Both	Boys	Girls	Both
PQ	47.9	31.8	39.8	48.2	41.8	45.0
MQ	46.7	31.2	39.0	49.1	44.5	46.8
PS	44.6	33.9	39.3	51.6	45.8	48.7
MS	44.0	28.0	36.0	49.8	42.4	46.1
C1	41.8	29.2	35.5	52.6	42.8	47.7
C2	48.4	34.9	41.7	50.7	45.4	48.1

By Schools

Schools	"Wrenches" Film				"Snakes" Film			
	Version	Boys	Girls	Both	Version	Boys	Girls	Both
A	C1	41.8	29.2	35.5	C2	50.7	45.4	48.1
B	C2	48.4	34.9	41.7	MS	49.8	42.4	46.1
C	PQ	47.9	31.8	39.8	PS	51.6	45.8	48.7
D	PS	44.6	33.9	39.3	MQ	49.1	44.5	46.8
E	MQ	46.7	31.2	39.0	C1	52.6	42.8	47.7
F	MS	44.0	28.0	36.0	PQ	48.2	41.8	45.0

As previously stated, one purpose of this project was to determine whether or not differences in film subject matter would influence the relative effectiveness of inserted questions or statements. The subject matter was varied by using two types of films: a technical film and a general information film. If inserted questions or statements were found to enhance the learning of the subject matter in *both* the technical film and the general information film, a greater claim could be made for their general use in instructional films.

As the results indicate, no *outstanding* merit was found in the use of either the inserted questions or inserted statements when film subject matter was varied. Also, little can be concluded concerning their effectiveness with specific film content. This is due to the inconsistent sex differences found in the relative effectiveness of the various film

versions. All differences were so small that the value of inserted questions and statements appears to be obscured by the inter-school variability inherent in matching students across schools for age, sex, and mental ability.

In view of these considerations, tables showing the inter-methods differences and the probability that each difference exceeded chance at a given level of confidence will not be included in this report.[9] In general, a difference of 1.5 to 2 score points was significant at at least the five per cent level of confidence for the 74-item test on the "Snakes" film. A difference of about 3 score points was generally significant at at least the five per cent level for the 71-item test on the "Wrenches" film.

The most consistent results are those for the C2 (repetition) version. They suggest that showing the film *twice* is about as good as using inserted questions or statements.

Part test score results. It was possible to score separately (1) those items emphasized in the "persistent" versions, (2) those items emphasized in the "medium" versions (these were also in the "persistent" versions), (3) those items ***not*** emphasized in the "persistent" versions, and (4) those items ***not emphasized*** in the "medium" versions. The part scores relating to the emphasized and unemphasized items are reported in Table III. Both the "persistent" level versions and the "medium" level versions are compared with the control version C1, and the repetition version C2.

For the emphasized items themselves, either repetition (in version C2) or emphasis with statements (PS or MS) or questions (PQ or MQ) generally resulted in more recall than the C1 version (the base film shown once). In fifteen out of the eighteen possible comparisons in part A of Table III, the experimental versions were better than the C1 control version. This was also true of part C. The performance of the boys on the test for the "Snakes" film accounted for exceptions. This finding parallels the results for the boys on the total test for this film. The other comparisons in the table do not yield consistent differences. Thus, while some of the individual differences are significant in a sampling sense, the inconsistency of direction of difference prohibits any firm conclusion from analysis of the part scores.

In general, for these films and this population, showing the film twice was about as effective for teaching specific important points as was emphasizing these points directly in the films by means of participation questions or reinforcing statements.

Parts B and D of Table III show that the items which were ***not*** specifically emphasized either by questions or statements were gen-

[9] These data are presented in Walter, Jeanette Sprecher, and Brenner, Henry Richard. *The Effects of Inserted Questions and Statements on Film Learning*, 1949, M. S. thesis, Pennsylvania State College. Tables 2 through 26.

erally learned better when presented two times than when presented in any of the other experimental versions. This was true in 34 of the 36 possible comparisons.

TABLE III

MEAN SCORES ON PART TESTS FOR BOTH FILMS

A. Items Emphasized at the Persistent Level

Version	"Wrenches" (25 Items)			"Snakes" (20 Items)		
	Boys	Girls	Both	Boys	Girls	Both
PQ	18.8	12.4	15.6	14.7	13.8	14.2
PS	17.1	13.7	15.4	15.9	14.9	15.4
C1	15.6	11.3	13.4	14.7	12.3	13.5
C2	18.3	13.1	15.7	13.8	12.9	13.4

B. Items Not Emphasized (for Persistent Level Comparison)

Version	"Wrenches" (46 Items)			"Snakes" (54 Items)		
	Boys	Girls	Both	Boys	Girls	Both
PQ	29.0	19.4	24.2	33.4	28.1	30.7
PS	27.5	20.3	23.9	35.7	30.9	33.3
C1	26.2	18.0	22.1	38.0	30.5	34.2
C2	30.0	21.9	26.0	37.0	32.5	34.7

C. Items Emphasized at the Medium Level

Version	"Wrenches" (13 Items)			"Snakes" (10 Items)		
	Boys	Girls	Both	Boys	Girls	Both
MQ	8.6	5.9	7.3	7.4	7.1	7.2
MS	8.4	5.5	7.0	7.7	7.2	7.5
C1	7.3	5.3	6.3	7.4	5.8	6.6
C2	8.8	6.2	7.5	6.8	6.1	6.5

D. Items Not Emphasized (for Medium Level Comparison)

Version	"Wrenches" (58 Items)			"Snakes" (64 Items)		
	Boys	Girls	Both	Boys	Girls	Both
MQ	38.1	25.3	31.7	41.7	37.5	39.6
MS	35.6	22.5	29.0	42.1	35.2	38.7
C1	34.5	24.0	29.2	45.3	37.0	41.1
C2	39.6	28.8	34.2	43.9	39.3	41.6

CONCLUSIONS

The conclusions indicated by the results of this experiment may be summarized as follows:

1. Inconsistent sex differences were found in the relative effectiveness of the various film versions in terms of total amount of material learned, and, to a lesser extent, in terms of the amount of emphasized and nonemphasized material learned. (See conclusions 4 and 5.)

2. In general, the results of the retention tests substantiated those of the immediate tests.

3. In the case of the *boys* there is a more clear-cut tendency for the effectiveness of the different film versions to vary.

4. In terms of total learning scores of the *girls* on both films, the film shown two times and the "persistent statements" version gave similar results and were more effective than the other versions.

5. On the other hand, in terms of total learning scores for the *boys*, with the possible exception of the film shown two times, no version showed a marked superiority on both films.

6. Material was generally learned better when emphasized by either statements or questions than when it was shown once without emphasis. Showing the Technical Film two times without emphasis was nearly as effective as the emphasized versions; but the showing of the General Information Film two times was not similarly effective.

7. For both boys and girls, and for both films, material which was not specifically emphasized was usually learned better when presented two times than it was learned when presented in any of the other film versions. In some instances, some other versions were about equally good, but no other version maintained such uniform superiority as did the film shown two times.

8. Spread of learning increment from the emphasized to the non emphasized material was much less than might have been expected.

9. All differences were small, especially those on items not specifically emphasized in some manner. Hence the expense of inserting such statements and questions as these in existing films would scarcely seem to be justified. (The maximum increase over showing a film one time was never greater than 6.1 items out of over 70 items in the total film tests; the maximum increase over showing a film two times was never greater than .9 items.)

10. This experiment has shown the effectiveness of mere repetition in increasing film learning by the simple and inexpensive procedure of showing a film two times in succession.

NEW CONSERVATION EDITOR

Beginning with this issue of SCHOOL SCIENCE AND MATHEMATICS, Professor Howard H. Michaud assumes the duties of Conservation Editor. Professor Michaud is Professor of Conservation at Purdue University, W. Lafayette, Indiana.

BALLOON LIFTS TWO TONS TO ALTITUDE OF 104,000 FEET

The world's largest balloon has lifted almost two tons of military equipment and instruments to an altitude of more than 104,000 feet.

This is the heaviest load ever carried by a balloon, the Air Force Air Research and Development Command said. The helium-filled balloon, 200 feet in diameter, weighed 1,500 pounds, with a volume of 3,750,000 cubic feet.

The launching was part of a series of tests to learn about the atmosphere 20 miles and more above the earth's surface.

TEST SATELLITE TRACKING STATIONS BY RADAR BOUNCED OFF MOON

The radio tracking stations for the earth satellites to be launched during the International Geophysical Year can be tested by bouncing radar signals off the moon.

Beams from the powerful radar antenna at the Army Signal Corps Engineering Laboratories in New Jersey were picked up by the Navy's Minitrack facility at Blossom Point, Md., after being reflected from the moon.

Purpose of the tests is to perfect a technique by which the operation of all the satellite tracking stations in the Western Hemisphere planned for a line of eight that stretches from Maryland to Santiago, Chile can be tested as soon as they are in operation.

LEARN HOW VIRUSES KILL LIVING CELLS AND SPREAD

How viruses execute living cells and spread infection may be explained by research just reported by University of California scientists in the *Journal of General Physiology*.

Apparently when viruses invade an injured cell, they force the cell to manufacture a special kind of chemical—an enzyme called virolysin. This chemical attacks a sugar-like substance that holds the cell wall together, causing a virtual explosion of the cell wall. In the explosion, the viruses are released, to invade other cells.

This picture of virus infection is suggested by Drs. Doris J. Ralston, Miriam Lieberman, Beatrice S. Baer, and Dr. A. P. Krueger of the department of bacteriology, whose research was supported by the Office of Naval Research.

The scientists discovered virolysin about two years ago. At that time they were studying another cell-exploding enzyme called autolysin, which bursts cells after they are dead. Virolysin was popping cells prematurely.

The scientists showed that virolysin is present only in infected cells and not in normal ones. Autolysin, on the other hand, is present in both normal and infected cells.

The demonstration that viruses can force a cell to manufacture a new enzyme, namely virolysin, is the first time this capacity of viruses has been demonstrated.

The work is the first experimental evidence of the correctness of the theory upon which extensive research for anti-viral drugs has been based, namely, that viruses can generate new enzyme systems.

The work thus strengthens the hope that the current line of drug research may succeed. A successful drug against a virus probably would be one that will destroy only the new enzyme produced by the virus without affecting the normal components of the cell.

The research was done with viruses which attack bacteria.

PHYSICISTS WRITE BOOKS ALSO

SISTER M. STEPHANIE
Georgian Court College, Lakewood, N. J.

During a freshman college course in general physics there is extremely little opportunity for outside reading. The student is trying continually to keep abreast of laboratory work, laboratory reports that must be done, lecture material, and that always essential preparation for tests. When will he have time for reading about earlier physicists, how the important discoveries came to be made, even about what erroneous opinions were first held until those with greater minds or greater insight came along with correct views? Granted, there is little opportunity during the first year. But, as the student makes progress in college and in physics he will have an increasing desire to know more of the work of those who preceded him. As he advances in physics he will, of course, have to read many articles in the periodicals in his field. But, these articles do not form the subject of this paper. Its purpose is to give a brief list of books that have been found useful for student enrichment at a freshman general physics level, and in a course in Modern Physics. If a seminar in physics is held, or a course given under the title of "Reading List," many of these same books can be included. Many of the books named can be read with profit by a mature high-school student. Who knows but what some stimulating autobiography might be the inspiration to a high school senior to follow a life career in theoretical physics?

Perhaps a good place to begin would be with Cajori's **History of Physics.** This volume is similar to the author's **History of Mathematics** in that it gives detailed information about developments in the field in the order of their occurrence with emphasis on the lives of those who made contributions. It chronicles all pertinent history until 1929.

Many biographies are available of different degrees of difficulty and of widely varying degrees of literary excellence. At the top of the list of classical physicists is the greatest physicist of them all, Newton, of whom it was said that it was given to only one man to discover the system of the universe. J. W. N. Sullivan's book, **Isaac Newton,** is well and clearly written and gives an excellent picture of the man Newton. Then there is **Robert Hooke** by Margereta 'Espinasse, a scholarly work, recent, complete with bibliography and footnotes. Hooke was involved in so many studies and so many projects from snowflakes to compound eyes of flies that it is hard to know whether to classify him as a physicist or not. At any rate his life makes interesting reading. **Christian Huygens** by Bell is not written in popular style and pre-

supposes on the part of the reader some previous acquaintance with physics for Huygens' optical formulas are all derived in the text. The book is well illustrated with line drawings. A standard and useful biography is **The Life and Works of the Honorable Robert Boyle** by More. There are several other lives of Boyle available, but this one seems the most readable at this level.

In the field of electricity there is **A Tribute to Michael Faraday.** The preface states that this is the "story of his parentage, his environment, his mode of thought and operation, his sympathies, his difficulties, his victories, and his passion for truth." Author Appleyard attempts a great deal—and is successful. An old-fashioned and difficult book, included here to make the record complete, is the **Life of James Clerk Maxwell.**

The number of American physicists in America in the nineteenth century was small indeed but these, too, have their biographers. Muriel Rukeyser is the author of **Willard Gibbs** and Thomas Coulson of **Joseph Henry.** Henry, discoverer of the phenomenon of self-induction, and less well-known as the first director of the Smithsonian Institution, deserves greater recognition by students. This book is excellent, written in a clear and readable style, but with all necessary information included.

Where should modern physics begin? At 1890? Where more appropriately than with the Curies? Everyone is familiar with the popular biography **Madame Curie** by her daughter Eve; not so many know of **Pierre Curie,** written by his wife Marie. Both should be read for an appreciation of the tremendous labor and discovery of this dedicated pair.

There is a two volume work on the **Life of William Thomson** by Silvanus P. Thompson but it is difficult reading. If someone needs just the salient facts about the same man he should read **Lord Kelvin.** This is a pamphlet but very good and the information obtained from it will remain in the students' minds longer than what they may glean from the two volume work. **The Autobiography of Robert A. Millikan** is almost too well-known to be named here. Probably every physics teacher has at some time assigned the chapter called "My Oil-Drop Venture" from this book to his students and it still bears re-reading. Max Planck's **Scientific Autobiography** gives Planck's thoughts on the limitations of exact science.

Innumerable books about Albert Einstein have been written varying from **Einstein, a Pictorial Biography** (all pictures), to **Einstein, His Life and Times,** translated from the German. A fairly popular account is **Albert Einstein** by Reiser who knew him well. This contains a preface written by Einstein.

Recent books are **Life Among the Atoms,** the story of Enrico Fermi

by his wife—extremely readable, parts appeared first in the **New Yorker**—and this year's **Atomic Quest,** the autobiography of Arthur Holly Compton.

Two collected biographies by Crowther, **British Scientists of the 20th Century** and **Famous American Men of Science** contain the lives of such men as Rutherford, Eddington, Henry and Gibbs. They are closely written, packed with information, and rewarding.

So much for biography. It is not intended that the student read all of these, but the list should contain enough material that something will be found to suit each taste. Various surveys of physical discovery have been written, one of the newest being **The Rise of the New Physics,** which is obtainable in a two volume paper-bound edition. This, in spite of its paper binding and innocuous appearance (rather like a college review book), is not an easy book and contains a fair amount of mathematics. It is clearly written and the material covered includes part of classical physics and the rise of quantum physics. Darrow's **New World of Physical Discovery** is a popular non-technical treatment of the new physics, now a little out of date since much has happened since 1930. **The Bases of Modern Science,** "an attempt to expound the main ideas of physical science in non-technical language," devotes chapters to Kepler, ether, heat and energy, and relativity. It is non-mathematical, but not too simple.

Not surveys at all, but good theoretical physics books, are Millikan's classic **Electrons (+ and −), Protons, Photons, Neutrons, Mesotrons, and Cosmic Rays** and Bragg's **Concerning the Nature of Things.** The first grew out of the Messenger Lectures delivered at Cornell and has been revised numerous times. In it are described the determination of e, the charge on an electron, Brownian movement in gases, and the structure of the atom. Bragg's book, too, started as a series of lectures. Since 1825 it has been the custom to have a series of Juvenile Lectures at the Royal Institute in London. Over the years lectures have been delivered by Faraday, Fleming, S. P. Thompson, and physicists of similar stature. Sir William Bragg delivered his lectures about 1924 and they contain much valuable (and decidedly not juvenile!) material on the nature of gases, liquids and solids. Particularly important is the work on crystals: diamond, ice and snow, and finally, metals.

Two important books difficult to classify but necessary for every physics library are Glasstone's **Source Book on Atomic Energy** and Chalmers' **Historic Researches.** The **Source Book** is a systematically ordered, two-column, textbook-like volume containing a wealth of information. It was prepared for the use of textbook authors and reporters. **Historic Researches** is a valuable addition to any library. This gives an historical account of physical experiments describing

(with excellent line drawings of all the original apparatus) the early experiments that led up to the ones performed presently in high school and college laboratories. For example, in the chapter on the mechanical equivalent of heat is given the work of Rutherford and Davy, Meyer and Joule, and all of Joule's later experiments. The book is written to satisfy the desire to learn, on the part of students "who made a discovery, what led up to it, how he came to make it, and against what background of contemporary thought and achievement it was made."

Finally, on the lighter side, are Gamow's two classics, **Mr. Tompkins in Wonderland** and **Mr. Tompkins Explores the Atom.** While written for the layman, they contain material set forth in such an original way that the physicist's temptation is to say, "I wish I'd said that!"

In this list no mention is made of textbooks nor of periodical articles, although these are abundant. Rather heavy emphasis is placed on biography because a knowledge of the man frequently helps in the knowledge of his work. One last note might be added that there is a tremendous amount of material on physics in Newman's recently published **The World of Mathematics.** Much of the work of the best physicists appears there in its original form, work that is now almost impossible to obtain elsewhere. Let not the title of the four volume work mislead you into thinking it contains no physics!

Bibliography

Appleyard, Rollo, **A Tribute to Michael Faraday,** Constable and Co., London, 1931.

Bell, A. E., **Christian Huygens,** Edward Arnold Co., London, 1947.

Bragg, Sir William, **Concerning the Nature of Things,** Harper and Brothers, New York, 1925.

Campbell, Lewis and Garnett, W., **Life of James Clerk Maxwell,** Macmillan, New York, 1884.

Chalmers, T. W., **Historic Researches—Chapters in the History of Physical and Chemical Discovery,** Morgan Brothers, London, 1949.

Compton, Arthur Holly, **Atomic Quest; a Personal Narrative,** Oxford, New York, 1956.

Coulson, Thomas, **Joseph Henry,** Princeton University Press, Princeton, 1950.

Crowther, J. D., **Famous American Men of Science,** W. W. Norton, New York, 1933.

———, **British Scientists of the Twentieth Century,** Routledge, London, 1952.

Curie, Eve, **Madame Curie,** Doubleday, New York, 1938.

Curie, Marie, **Pierre Curie,** Macmillan, New York, 1923.

D'Abro, A., **The Rise of the New Physics,** 2 vol., Dover Publications, New York, 1951.

Darrow, Floyd, **The New World of Physical Discovery,** Bobbs-Merrill, Indianapolis, 1930.

'Espinasse, Margareta, **Robert Hooke,** William Heinemann, Ltd., London, 1956.

Fermi, Laura, **Life Among the Atoms,** University of Chicago Press, Chicago, 1954.
Frank, Philipp, **Einstein, his Life and Times,** Alfred A. Knopf, New York, 1947.
Gamow, George, **Mr. Tompkins in Wonderland,** University Press, Cambridge, 1940.
———, **Mr. Tompkins Explores the Atom,** University Press, Cambridge, 1951.
Glasstone, Samuel. **Source Book of Atomic Energy,** D. Van Nostrand Inc., New York, 1950.
Millikan, Robert A. **The Autobiography of Robert A Millikan,** Prentice-Hall, New York, 1950.
———, **Electrons (+ and −), Protons, Photons, Neutrons, Mesotrons, and Cosmic Rays,** University of Chicago Press, 1927.
More, Louis T. **The Life and Works of the Honorable Robert A. Boyle,** Oxford University Press, New York, 1944.
Newman, James R., **The World of Mathematics,** 4 vol., Simon and Schuster, New York, 1956.
Planck, Max, **Scientific Autobiography and other Papers,** Philosophical Library, New York, 1949.
Reiser, Anton, **Albert Einstein,** Albert and Charles Boni, New York, 1930.
Rukeyser, Muriel, **Williard Gibbs,** Doubleday, Doran, Inc., New York, 1942.
Sullivan, J. W. N., **Isaac Newton, 1642–1727,** Macmillan, New York, 1938.
———, **The Bases of Modern Science,** Ernest Benn, Ltd., London, 1928.
Thompson, Silvanus P., **Life of William Thomson,** 2 vol., Macmillan, London, 1948.
Young, A. P., **Lord Kelvin,** Longmans, Green and Co., London, 1948.

AIR FORCE GETS SUPER FUEL; QUANTITY PRODUCTION STARTED

New high-energy "super" fuels that increase jet aircraft ranges up to 50% and eliminate high altitude engine failures have gone into semi-commercial production for the Air Force.

A spokesman for Olin Mathieson Chemical Corporation, developer and producer of the new chemical fuels, said small quantities of the fuels already have been shipped to the Air Force from a semi-commercial plant. A plant designed for full-scale production is expected to be in operation within 20 months.

Dr. L. K. Herndon, head of the high-energy fuels operation, said the new compounds are based on derivatives of boron, a non-metallic element previously known chiefly as the main ingredient of borax washing compounds and boric acid. He said the new fuels meet all Air Force requirements for ultra high energy as well as for easy and safe handling features.

Brig. Gen. C. H. Mitchell, deputy production director of the Air Force's Procurement and Production Directorate, described the delivery of the first high energy fuels as a break-through signifying greater strength for the United States. Speaking for the Air Force, Gen. Mitchell said the new fuels would enable jet aircraft engines to function efficiently at high altitudes where low wind resistance would make flying faster.

The new "exotic fuels" are planned for use in aircraft and are not being adapted to automobile or other surface transportation use. Olin Mathieson executive vice president W. C. Foster told newsmen he expects the fuels announced today to be the forerunners of what will amount to a $1,000,000,000 industry within 10 years

SCOPE AND SEQUENCE OF ELEMENTARY SCHOOL SCIENCE

RICHARD F. BRUNS
Teacher on Special Assignment, Department of Curriculum and Instruction, Houston (Texas) Public Schools

AND

ALEXANDER FRAZIER
Assistant Superintendent in Charge of Educational Services, Phoenix (Arizona) Union High School and Junior College System

SCOPE AND SEQUENCE OF ELEMENTARY SCHOOL SCIENCE: A SURVEY

This analysis of trends and practices pertaining to the scope and sequence of science instruction in elementary schools is based on a survey of the science programs of twenty-one large city school systems[1] in various parts of the country. In making the survey, the writers have examined and analyzed courses of study, teachers' guides, handbooks, and various other types of resource bulletins published by these systems for the implementation of their science teaching programs.

DIFFERENCES IN ORGANIZATION

From a study of this material there appears to be no well-defined pattern of scope and sequence for science topics that can be identified as basic to the elementary curriculum of any significant number of the school systems included in the survey. While there are a number of similarities to be found and some characteristics that can be considered as fairly widespread, apparently there is no single clear-cut pattern that can be seen as typical of even a small number of these major school systems.

One characteristic found to be common to more than half the school systems covered in the study is the tendency to organize all science topics at each grade level around the same basic framework, grouping topics under several broad areas of learning and then repeating this statement of scope at each grade level or at two- or three-year intervals. The procedures outlined by these systems indicate that, as the basic science topics are repeated, more mature concepts and broader understandings are sought in each area of learning. Specially-prepared science resource books are available in many

[1] Baltimore, Maryland; Chicago, Illinois; Cincinnati, Ohio; Cleveland, Ohio; Dallas, Texas; Dayton, Ohio; Houston, Texas; Indianapolis, Indiana; Louisville, Kentucky; Milwaukee, Wisconsin; Minneapolis, Minnesota; Newark, New Jersey; New York, New York; Oakland, California; Los Angeles (City Schools), California; Pittsburgh, Pennsylvania; Saint Louis, Missouri; Saint Paul, Minnesota; San Antonio, Texas; San Francisco, California; and Tulsa, Oklahoma.

cases to assist teachers in developing broader concepts as children grow in understanding.[2]

Types of Organization

Some school systems appear to have developed an over-all sequence extending from Kindergarten through Grade Six and emphasizing specific experiences in certain designated areas of science learning at each grade level. However, there seems to be no real agreement among these systems as to which of the designated areas of learning should be assigned to a particular grade level. Outside of a tendency to develop science topics concerning observations of plants and animals, weather and climate, and seasons of the year within the primary curriculum and to assign the study of more advanced physical phenomena, natural forces, and matter and energy to the intermediate grades, there is little evidence of any generally accepted pattern for developmental sequence. Further complicating the picture is the fact that some of these school systems organize their elementary science programs in terms of two-year blocks (Grades K-2, 3–4, and 5–6) and others on a three-year basis (Grades K-3 and 4–6).

There seem to be three approaches to establishing scope and sequence among the twenty-one schools. Four of the school systems have a science program which repeats essentially the same scope at succeeding grade levels, covering similar material each time but adding new concepts and understandings. The sequence in ten other school systems follows a basic outline that is repeated in subsequent grade levels but with variations in subject matter and types of learning units according to the maturity level of the pupils concerned. Seven of the twenty-one school systems have adopted an over-all sequence for the elementary grades, assigning specific fields of science study at designated grade levels.

Grade Placement of Science Topics

In order to study the grade placement of science topics under these varying types of scope and sequence patterns, the writers have an-

[2] Examples are:

A Source Book of Science Experiences for Elementary Children (Volume One, Parts 1 and 2, for Kindergarten and Primary Grades, K–1–2–3; Volume Two, Parts 1, 2, and 3, for Intermediate Grades, 4–5–6). Revised Edition. Curriculum Bulletin 11, Division of Curriculum, Louisville Public Schools, Louisville, Kentucky, September, 1954.

Teachers' Guide for Elementary Science: Grade I (Also Grade II and Grade III). Tulsa Public Schools, Tulsa, Oklahoma, Revised 1951.

Science Course of Study, Cleveland Elementary Schools: Fourth Grade (Also Fifth Grade and Sixth Grade). Cleveland Public Schools, Cleveland, Ohio, 1943, 1945, and 1948, respectively. (Includes resource material with course of study.)

Illustrative Science Units for Elementary Grades. Curriculum Bulletin #52, St. Paul Public Schools, St. Paul, Minnesota, 1955.

A Source Book of Materials for Teaching Science in the Elementary Schools. School Publication #461, Los Angeles City School Districts, Los Angeles, California, 1949 (reprinted in 1956).

Science for the Intermediate Grades. Curriculum Bulletin #19, Indianapolis Public Schools, Indianapolis, Indiana, March, 1955.

alyzed the programs and summarized the results in terms of three grade levels, as shown in Table I. In the process, the science topics ordinarily taught in the elementary schools were first categorized under 18 subject headings. Then topic placements were recorded at

TABLE I

TRENDS IN GRADE PLACEMENT OF SCIENCE TOPICS AS SHOWN BY A SURVEY OF LARGER SCHOOL SYSTEMS

(NOTE: The figures in this table represent the number of school systems in the survey which provide for the teaching of science topics in each area at each of three designated grade levels. Figures at the bottom of the table show the total number of school systems for which a list of science topics was available at each level.)

Areas of Science Learning	Grades		
	K-2	3–4	5–6
LIVING THINGS IN GENERAL: Basic Needs; Interrelationships of Plants and Animals	14	12	12
CLASSIFICATIONS OF LIVING THINGS: Individual Types and Species; Adaptations to Environment; Methods of Protection and Food-Getting; Life Cycles and Propagation	7	9	14
CONSERVATION: Values and Utilization of Plants and Animals, Soil, and Resources	4	5	9
WEATHER, CLIMATE, AND SEASON: Variations in Weather Patterns; Causes and Effects	13	10	15
AIR AND WATER: The Properties of Air and Water; The Atmosphere; The Water Cycle	7	9	11
HEAT AND LIGHT: Effects of Heat and How It Is Used; Source of Light and Its Value to Us	6	6	12
SOUND AND HEARING: Nature of Sound; How We Use Different Kinds of Sound	4	8	10
THE SUN: Our Principal Source of Energy; Its Nature and Relationship to the Earth	10	8	4
THE EARTH: Shape and Movements of the Earth; Composition of the Earth; Gravity	5	7	5
THE MOON AND THE STARS: Their Nature and Their Relationships to the Earth	5	8	7
THE SOLAR SYSTEM: "The Sun's Family"; Relationship of the Sun, Planets, and Satellites	1	4	10
EARTH'S SURFACE: How It Changes; Land and Water Areas and the Forces Acting on Them	1	5	8
SOIL, ROCKS, AND MINERALS: Their Composition and Their Value as Natural Resources	5	5	9
MATTER AND ENERGY: Nature of Solids, Liquids, Gases; Elements, Mixtures, Compounds; Principles of Work and Energy	4	3	12
MAGNETISM: Magnets and Their Uses; Principles of Magnetism; Compass	6	13	10
ELECTRICITY: Its Usages and Methods of Control; Principles of Electric Currents	4	8	16
SIMPLE MACHINES: Basic Principles Involved in Levers, Inclined Planes, Pulleys, Wheel and Axle	8	9	7
HEALTH AND SAFETY: Food and Nutrition; Prevention of Disease and Accidents	4	4	4
TOTAL NUMBER OF SCHOOL SYSTEMS for which a list of science topics was available at this grade level	14	14	16

three levels (Grades K-2, 3–4, and 5–6) for those systems whose science program is organized on a yearly or bi-yearly basis.[3]

The numbers listed in each grade-column represent the number of school systems which provide for the teaching of science topics under each of the subject headings at that particular grade level. For instance, under the Grade K-2 column it will be seen that 14 of the school systems surveyed provide for the teaching of science topics relating to "Living Things in General" at Grades Kindergarten, One, or Two; seven of the systems provide for topics concerning "Classifications of Living Things" at this grade level; etc.

A study of this table reveals that although there is incomplete agreement among these school systems as to the exclusive placement for any one of these topic fields, there is in many cases a tendency for some of the topic offerings to "bunch" at one or more grade levels. This bunching may be interpreted to indicate a trend toward assigning certain kinds of topics more frequently at these grade levels than at others.

For example, it is apparent that topics dealing with "Living Things in General" are taught in most of the school systems surveyed at all three of the levels indicated. On the other hand, topics dealing with "Classifications of Living Things," while being taught in half of the systems at Grades K-2 and more than half of them at Grades 3-4, are taught in a predominant number of the systems at Grades 5–6.

Topics concerning "The Sun: Our Principal Source of Energy" are taught in Grades K-2 and 3–4 by a majority of the systems studied, but only a small number included these topics at Grades 5–6. Studies of "The Earth" and "The Moon and the Stars" are made at all levels, but there is a slight preference among these school systems for Grades 3–4. Few studies of "Sound and Hearing" are made at Grades K-2, but more than half the systems in the survey have these topics assigned at Grades 3–4 and 5–6. Studies of "Matter and Energy" are attempted by few systems at Grades K-2 and 3–4, but three-fourths of the group include these topics at Grades 5–6. While only a few systems provide for a study of electricity at Grades K-2, more than half the survey group take up this subject at Grades 3–4 and all of them include a study of electricity at Grades 5–6.

Pattern of Preference

Certain generalizations may also be attempted from this table as to what seems most often to be considered appropriate for study at each level. For example, it appears that most of the science experiences developed at Grades K-2 in these school systems are concerned

[3] This excluded five of the school systems, those whose science programs are differentiated only between grades K–3 and 4–6.

with observations of simple phenomena encountered in everyday experiences and the basic differences to be found among living things and the environments in which they live. At Grades Three and Four, these observations seem to be intensified to develop an understanding of the relationships between living things and their environment and some basic principles of cause and effect. Most science experiences in Grades Five and Six appear to utilize the experimental approach for developing an understanding of life processes, natural forces, and earth's elements, and how they are controlled and used by man for the betterment of life.

Another generalization that might be drawn from this table concerns possible evidences of a developmental sequence. Those topics dealing with the normal daily experiences of pupils appear to be taught generally at all grade levels in these school systems, with adaptations according to age made to provide for continuous growth in pupil concepts. Topics concerning living things in general and their basic needs and interrelationships, for example, are provided uniformly at all levels from Kindergarten through Grade Six. Similar provision is made for topics dealing with weather, climate, and seasons. There seems to be a gradual growth in emphasis from grade to grade for other topics that relate closely to these but require a greater understanding of the principles of cause and effect or that develop more specific applications of knowledge, such as classifications of living things and properties of air and water.

Topics which develop abstract concepts, even though based on simple observations of natural phenomena, are usually deferred to Grades Three and Four. Such subjects as the nature of sound, shape and movements of the Earth, relationships of the moon and stars to Earth, and principles of simple machines seem to be taken up most frequently at this level. However, emphasis on these areas tends to drop off in Grades Five and Six. In other areas of learning, such as the nature of sound and principles of magnetism and electricity, subject emphasis apparently continues strong or increases in Grades Five and Six.

Finally, such topics as heat and light; the solar system; changes in the Earth's surface; soil, rocks, and minerals; and the study of matter and energy, which normally involve an experimental approach and require some knowledge of natural forces and a good understanding of the principles of cause and effect, appear to be developed most frequently at Grades Five and Six.

From this study of the apparent groupings at the three different grade levels, a descriptive pattern of preference for science topic placement among the school systems surveyed can be drawn, as shown in Table II. Obviously, the information from which this pattern has

been developed is limited and the use of the description should be accompanied by reference to the actual courses and study and other bulletins on which it and the preceding table have been based.

TABLE II

PATTERN OF PREFERENCE FOR SCIENCE TOPIC PLACEMENT AMONG SCHOOL SYSTEMS SURVEYED

Grade Level	Topics
KINDERGARTEN GRADES 1 AND 2	LIVING THINGS IN GENERAL: Basic Needs for Life and Growth INTERRELATIONSHIPS OF PLANTS AND ANIMALS WAYS IN WHICH PLANTS AND ANIMALS DIFFER WEATHER, CLIMATE, AND SEASONS (Observations) AIR AND WATER: Basic Properties and Uses THE SUN: The Importance of the Sun to Living Things SIMPLE MACHINES: As Illustrated in Toys and Household Tools HEALTH AND SAFETY (Included by some schools in science units)
GRADES 3 AND 4	LIVING THINGS IN GENERAL: Basic Needs and Interrelationships CLASSIFICATION OF LIVING THINGS: Individual Groups; Adaptations to Environment; Methods of Protection, Food-Getting WEATHER, CLIMATE, AND SEASONS: Variations in Weather Patterns; Causes of Seasons AIR AND WATER: Atmosphere, Water Cycle SOUND AND HEARING: Kinds of Sounds and How We Use Them THE SUN: Its Nature and Its Relationship to Earth THE EARTH: Shape of the Earth and Its Movements; Gravity THE MOON AND THE STARS: Nature and Relationships to Earth MAGNETISM: Magnets and Their Uses ELECTRICITY: How It Is Used and Controlled SIMPLE MACHINES: Basic Types and Principles of Operation HEALTH AND SAFETY (Included by some schools in science units)
GRADES 5 AND 6	LIVING THINGS IN GENERAL: Basic Needs and Interrelationships CLASSIFICATION OF LIVING THINGS: Individual Types and Species; Adaptations to Environment; Methods of Protection and Food-Getting; Life Cycles and Methods of Propagation CONSERVATION AND UTILIZATION OF PLANTS AND ANIMALS, SOIL, AND NATURAL RESOURCES WEATHER, CLIMATE, AND SEASONS: Causes and Effects of Weather Change AIR AND WATER: Nature of the Atmosphere; Water Cycle HEAT AND LIGHT: Effects and Uses SOUND AND HEARING: Nature of Sound and How We Use It SOLAR SYSTEM: The Sun's Family; Relationship of Sun, Planets, Satellites EARTH'S SURFACE AND HOW IT CHANGES: Land and Water Areas and the Forces Acting on Them SOIL, ROCKS, AND MINERALS: Their Composition and Value MATTER AND ENERGY: Solids, Liquids, and Gases; Elements, Mixtures, and Compounds; Principles of Work and Energy MAGNETISM: Principles and Uses ELECTRICITY: Principles and Uses HEALTH AND SAFETY (Included by some schools in science units)

PROBLEMS RAISED BY THE STUDY

This study seems to indicate that in the school systems surveyed the organization of the elementary science program is conceived of in the following terms:

Scope

Generally, all the major areas of science are included by one or more systems at each grade level, with some "bunching" of topics at some levels as indicated in the summary description of Table II but no complete agreement of division of responsibility for coverage of any given area at any grade level.

Apparently the approach as represented by these school systems is generally to deal in some fashion with most of the major aspects or areas of elementary science at every grade level.

Sequence

The sequential development of concepts, skills, and attitudes seems generally to be conceived as occurring through extending the experience of the pupil within each science area to include increasingly more challenging problems or projects.

The identification in detail of a sequence of development expected within each science area is not generally attempted.

At this point, then, it may be appropriate to define a number of problems or questions that seem to arise from or be unresolved by the study.

1. *Is an attempt to establish a more fully organized structure for scope and sequence in elementary science desirable?*

   Since no generally accepted structure of scope and sequence for elementary science seems to have been revealed in this survey, the question may arise concerning the desirability of trying to develop more structure.

   Blough and Huggett[4] reported in 1951 that investigations had shown that there was no great uniformity as yet in the selection of material for a given grade. "Perhaps this is a good thing," they said, "because a stereotyped course that designates specific experiences for each grade and holds rigidly to them has little to recommend it in the light of what we know about children's interests, how children learn, and how to work intelligently with them."

   On the other hand, they felt that although the so-called "incidental" interests of children cannot be ignored, neither can they form the chief basis for our courses, for if they do, valuable material is omitted and we may have a "hodgepodge" curriculum. Course outlines, these authors agreed, should help to ensure a sequence of subject matter from grade to grade through the elementary school.[5]

   The question of the value or desirability of making an effort to provide a more highly organized structure for the scope and sequence of the elementary science program thus becomes paramount in deciding whether to continue study and research in this area.

2. *Is it possible, even if desirable, to determine a detailed developmental sequence in elementary science?*

   One of the factors that would seem to make some sense of sequence advisable is the necessity for assigning learning tasks according to the pupil's level of maturation and experience. We must consider the "mental grasp" of our groups in selecting material for study, say Blough and Huggett. "Let us not plan to exhaust the subject, the children, and the teacher at the elementary level. Keep science simple at the early level."[6]

   Craig[7] reported in 1940 that evidence seemed to indicate that there is a natural sequence in elementary science. "Although at many places there may be alternate routes in the sequential development," he said, "in the main certain learning elements are necessary to the development of more comprehensive ones."

[4] Glenn O. Blough and Albert J. Huggett, *Elementary School Science and How to Teach It*. New York: The Dryden Press, 1951. Pp. 48–49.

[5] *Ibid.*, p. 8.

[6] *Ibid.*, p. 45.

[7] Gerald S. Craig, *Science for the Elementary-School Teacher*, p. 42.

Other writers also have reiterated the need for recognizing and exploring more fully the developmental and experiential levels of children. Herman and Nina Schneider,[8] for example, point out that although we are well aware of the need of the six-year-old for large-muscle activities and we choose science activities that do not require closely controlled movements, we should also be aware that this is a good time "to encourage him to sniff and listen, to feel textures and temperatures, to become aware of his surroundings and to report his sense impressions, to move toward a more confident use of himself."

Dunfee and Greenlee,[9] in a manuscript written for the Association for Supervision and Curriculum Development, report that educators seem agreed on the idea that science objectives in the elementary school should be concerned with directions for growth rather than final outcomes and that opportunities should be provided for the development of skills, attitudes, and appreciations as well as functional information.

The need for determining the age level at which children can best develop certain science learning skills, has been felt for some time. In 1937, Croxton stressed the need to know more about what children at the various age levels are able to accomplish. "How early is [a child] able to comprehend and utilize various facts, principles, and skills?" he wondered. "We know that some of these are relatively simple of understanding and application, while others are highly complex and difficult to comprehend, but we lack experimental evidence upon which to judge the difficulty of each for the child."[10]

Thus, the extent to which a detailed developmental sequence in elementary science can be established, even if desirable, depends in large part on how much we now know about growth of concepts, skills, and attitudes in this field. It well may be that considerable study and research will be required before the attempt to set up a more elaborate sequence is in order.

3. *Should the relationships between areas in science be stressed in organizing the elementary program?*

Apparently, as this study indicates, each area of science in the elementary program is likely to be treated in some fashion at most grade levels. One question this practice raises is this: Can each broad area of science learning be treated individually without building on learnings from other science areas?

In 1939, the faculty of the University of Chicago Laboratory Schools contended that in the elementary school the units and experiences planned for a given level are largely independent of one another; thus the order in which they occur is not significant.[11] This statement is applied specifically to experiences for "a given level."

Perhaps a re-examination of this attitude toward the relationships of the "separate" areas of elementary science might provide new insights into the need of creating a more closely integrated program within the field, if such be considered desirable.

4. *Should greater emphasis be sought in establishing relationships between science and other areas of study?*

One of the aspects that cannot be ignored in the review of any subject program is the nature of its relationship with other subject areas. Hanley

---

[8] Herman Schneider and Nina Schneider, "Role of Science in Child Development," 32nd Yearbook, *The National Elementary Principal*, Vol. XXXIII, No. 1, September, 1953, p. 15.

[9] Maxine Dunfee and Julian Greenlee, *Elementary Science Education*, unpublished manuscript, Association for Supervision and Curriculum Development, Washington, D. C.

[10] W. C. Croxton, *Science in the Elementary School*, p. 119.

[11] *Science Instruction in Elementary and High School Grades*, Publications of the Laboratory Schools, Number 7, The University of Chicago, September, 1939, p. 4.

and Schiesser,[12] for example, oppose any movement toward developing a "spiral" curriculum in science independent of the social studies. "Since most science facts are important to the child only in terms of their social significance," they claim, "this independent treatment of science is bound to fail in some degree to meet child needs. . . . In the elementary school there is no place for 'science for science's sake'."

Craig,[13] on the other hand, cautions against making "forced" correlations. The "vogue for centering science work around one dominating unit," he says, has led sometimes to "unnatural and forced correlation and has not always been congenial to a well-rounded development of the child."

However, the further assessment of relationships between science and other fields might well provide information that would help in the task of planning a science program in the elementary school so that its accumulated learnings would make their greatest impact on the lives of children.

These, then, are several live questions that remain to be answered as the area of elementary science is explored for more effective ways of organizing the program to meet today's needs. It would seem that continued study and research is needed in the whole area if better answers are to be found.

Bibliography

Science Instruction in Elementary and High-School Grades. Publications of the Laboratory Schools, Number 7. The University of Chicago, September, 1939.

Blough, Glenn O., and Albert J. Huggett. *Elementary School Science and How to Teach It.* New York: The Dryden Press, 1951.

Schneider, Herman, and Nina Schneider. "Role of Science in Child Development." Thirty-Second Yearbook Number, *The National Elementary Principal,* Vol. XXXIII, No. 1, September, 1953. Pp. 11–16.

Dunfee, Maxine, and Julian Greenlee. *Elementary Science Education.* Unpublished manuscript, Association for Supervision and Curriculum Development, Washington, D. C., 1956.

Croxton, W. C. *Science in the Elementary School.* New York: McGraw-Hill Book Company, 1937.

Craig, Gerald S. *Science for the Elementary-School Teacher.* Boston: Ginn and Company, 1940.

Hanley, George H., and Evelyn B. Schiesser. "A Point of View for Science." Thirty-Second Yearbook Number, *The National Elementary Principal,* Vol. XXXIII, No. 1, September, 1953. Pp. 17–21.

[12] George H. Hanley and Evelyn B. Schiesser, "A Point of View for Science," 32nd Yearbook, *The National Elementary Principal,* Vol. XXXIII, No. 1, September, 1953.

[13] Craig, *op. cit.,* p. 43.

NEW PLANT TO BE POWERED BY ITS OWN BY-PRODUCT

A modern chemical plant to be built for Atlas Powder Company will need no outside source of fuel once operations have started, it was announced here. After production begins in the new nitric acid and ammonium nitrate plant, the heat energy produced by burning ammonia as part of the production process will be channeled back into the operation to provide energy needed for reactions elsewhere in the plant.

THE USE OF THE FIELD TRIP IN SCIENCE

GEORGE GREISEN MALLINSON
Western Michigan University, Kalamazoo, Michigan

If one were to prepare a bibliography of articles from science journals extolling the possible values of field trips, it would no doubt "be as long as your arm." Indeed it might be as long as a dozen arms "laid end to end." Hence, another article dealing with field trips for science might well seem redundant. But, field trips in general do not seem to have lived up to the merits claimed for them. One teacher was heard to say that "the kids do not get enough out of them to make all the trouble organizing them worthwhile." Others state that "the kids just play around and pay no attention to what they should. I quit running field trips because there are too many discipline problems."

The purpose of this article is not to rehash the points that have appeared in the many already written about field trips. Nor is it to suggest that the points mentioned herein will be a panacea for all problems that may arise henceforth with field trips. Rather, it is to amplify some of the more cogent elements of these other articles, and to identify some of the errors which, in the writer's opinion, have been the cause of the difficulties.

THE FIELD TRIP? YES!

It would be platitudinous to cite all the evidence, both logical and psychological, that defends the use of field trips for science teaching. Research studies by the dozen have pointed out that direct experience far excells vicarious experience in the learning increments it produces. More sensory receptors of the student are stimulated with the direct experience. Further, all the elements of the learning experience are found in their proper relationships to one another. This latter situation is impossible if the learning experience is carried out in the classroom. But, it must be made clear that direct experiences *may not* be so satisfactory as vicarious unless certain safeguards are taken.

PLANNING THE TRIP

Naturally, every teacher intending to utilize a field trip should know thoroughly the area to be visited and be aware of its possibilities for learning. This may require more than one visitation, the first to identify the potential of the situation, the later ones to select the particular elements of the situation that are to be studied.

Here is one place where difficulties often arise. At least half of all science trips are taken to areas, industries or organizations where the

students are turned over to a guide, supervisor, foreman, caretaker, or superintendent who conducts the trip. It is regrettably true that such trips invariably fall short of what may be expected from them. The "conductors" of such trips are seldom trained teachers, many have little understanding of the activities of a science classroom, and few have had experience in working with groups of children. Hence, the field trips frequently degenerate into "inspection tours" during which the descriptions of the areas or activities are couched in terms far too difficult for the students to understand.

These difficulties cannot be blamed on the "conductor." Rather they fall directly on the teacher for failing to confer often and well enough in advance with those concerned. In many cases, such conferences may almost become training sessions during which the "conductors" are briefed specifically as to *how* to present the trip. Naturally, they will be aware of the subject-matter.

There is one precaution that needs to be taken with field trips for science at any level. The "conductors" should be carefully briefed about using technical terminology. Often the significance of entire segments of a trip is lost because the meaning of one term completely evades the students' understanding.

In many cases it may be desirable to forego a trip to a certain area or industry because suitable "conductors" are not available. Such is often most unfortunate since that area or industry may have tremendous potential which unfortunately cannot be realized.

Take It Easy!

A few years ago a Russian newspaper carried a story that several million mourners passed by the bier of Dictator Stalin in a period of a few days. It was later pointed out that their affection for the dear departed must have been fabulous since it would have been necessary for them to have run by the coffin at a speed of about eighty miles per hour in order for all to have obtained a glimpse. A brief glimpse it must have been! Unfortunately, this situation is often duplicated on field trips for science. The students are made to walk at a rapid pace through many activities meanwhile receiving "lectures" at a circus-barker pace. On their return, they claim to feel like a parrot that had been caught in a tornado! Obviously, the learning increment of such a trip is infinitesimal.

The factor of individual differences is involved also in the pace of the trip. Many students will wish to ask questions about the activities they observe simply because they do not understand them at first glance. The better students may wish to have their observations extended. Both desires are eminently desirable. However, they can be satisfied only if the pace is "slowed down."

Investigate—Don't Just Illustrate!

Many teachers have participated in field trips on which the instructor led the students in a file to a tree—the assistant leader at the end of the file to urge on the laggards. At the tree the instructor turned around and signalled the students to gather in a semi-circle.

When all were quiet—although not necessarily attentive—the instructor would seize a moving object from a leaf and announce, "This is a bug!" The group would again stretch out in file and move to another position where another specimen might be identified. With elementary children seldom does quiet even prevail on such a trip.

Those who conduct trips on such a basis, fail to attend to the extrinsic and intrinsic factors related to motivation. A student who is brought into the field where illustration is the only aim has the teacher in a compromising position. The students' sensory receptors are constantly being bombarded by thousands of stimuli, a few of which are the activities of the teacher. Thus the teacher is placed in the embarrassing situation of battling the multitude of stimuli for the complete, undivided attention of all the students. Obviously, partial success is the *best* that can be hoped for.

However, *if* the student has a personal motivation to attract him, then attention is much more likely to be assured. The personal motivation may be instilled by some degree by the following procedure:

1. Make clear well ahead of time exactly what the field trip is designed to accomplish.
2. Have each student write down several questions which the field trip activities are designed to answer. Indicate that the student will be held responsible. Obviously, the grade level of the student will determine the way in which they will be written down and the breadth of the answer. However, correct answering should require continuous attention.
3. Stipulate some exploration for each student. This will place the student in the capacity of a participant rather than a spectator.

There are, of course, many other suggestions that might be made. These however seem to be the ones that may answer the difficulties that seem to arise most frequently.

CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS

During the last few years the Board of Directors of the CASMT has given careful consideration to the problems involved in electing the officers of the Association. Recently the President appointed a

committee to study our election procedure and submit a proposal for the revision of the present method. The report of this committee follows.

PROPOSED PLANS FOR NOMINATION AND ELECTION OF OFFICERS

1. A Nominating Committee shall be appointed by the Executive Committee of the Board of Directors promptly following the annual meeting. Publication of the personnel of this committee shall be in an early issue of SCHOOL SCIENCE AND MATHEMATICS. At this time the membership shall be invited to make suggestions of prospective candidates to any member of the Nominating Committee.

2. The Nominating Committee shall consist of five (5) members, with the Chairman being chosen from the group by the Executive Committee. The personnel of the committee shall be so selected as to present a balanced representation of the Association according to sectional, geographical, and level-of-teaching areas of distribution.

3. It shall be the duty of the Nominating Committee to name two candidates each for the office of President and Vice-President, and twice as many candidates as there are positions to be filled on the Board of Directors. All nominees must be members of the Association currently in good standing and properly qualified. It shall be the responsibility of the Board of Directors, at the time of its Spring meeting, to determine whether all persons whose names appear on the list of nominees meet these conditions.

4. It shall be the duty of the Chairman of the Nominating Committee to secure from each nominee a professional biography, and from the nominees for President and Vice-President a glossy print of a recent photograph. This shall be done in time to provide copy for mailing to the membership of the Association at least five weeks prior to the date set for the annual meeting.

5. The Board of Directors shall designate at the Spring meeting the exact date for the official election which shall be held during the four weeks closing at 12 midnight of the date one week prior to the annual meeting. Ballots will be mailed to the members of the Association in good standing so that they may be returned during the official election period.

6. The votes shall be counted under the joint supervision of the Secretary of the Association and the Chairman of the Nominating Committee. In the event either of these persons cannot act the President shall appoint an alternate. The count shall be made in time to provide the President of the Association with the official results so that they may be presented to the Board of Directors at its first official session of the Annual meeting. In the event of close votes the Board of Directors may exercise the privilege of calling for a recount, and, in the event of a tie vote, it shall assume the responsibility of determining the procedure for selection of the candidate to be declared elected.

7. It shall be the duty of the President to announce the names of those elected. This shall be done at the time of the annual business meeting and published in an early issue of SCHOOL SCIENCE AND MATHEMATICS. No public announcement shall be made of the number of votes received by any candidate.

8. Make appropriate changes in the constitution for the inauguration of the suggested plan.

Respectfully submitted:
H. GLENN AYRE
MILTON O. PELLA
F. LYNWOOD WREN, *Chairman*

As a result of the preceding report, the Board of Directors approved the following Constitutional changes at their annual meeting

in May, 1957. As required by the Constitution, these proposed changes must be printed in the *Journal* in the two issues published prior to the annual meeting in November. Hence, they are presented below and will appear again in the November issue. These changes will then be voted on by the membership of CASMT at the Annual Meeting in Chicago in November.

CONSTITUTIONAL CHANGES NECESSARY TO INAUGURATE PROPOSED PLAN FOR NOMINATION AND ELECTION OF OFFICERS

In the left column appears the new wording of the affected part of each article of the constitution. In the right column appears the present wording of the same portion. The new words are italicized.

Article III, Section III. Election, Tenure of Office, and Compensation

(a) The President and Vice-President shall be elected by *a majority of the votes cast by members of the Association* and shall serve for a term of one year or until their successors are elected. The Treasurer and Business Manager . . . shall be fixed by the Board of Directors.	The President and Vice-President shall be elected by the members of the Association at the annual meeting and shall serve . . . shall be fixed by the Board of Directors.
(b) *The election of officers of the Association shall be by mail ballot to be held each year during the four weeks closing at 12 midnight of the date one week prior to the annual meeting. Official ballots, accompanied by professional biographies of all nominees and pictures of the nominees for President and Vice-President shall be mailed to the members at least five weeks prior to the date set for the annual meeting. Ballots, when properly marked, shall be returned to the Secretary of the Association to be held under seal until the time for the official count. In the event of close votes the Board of Directors may exercise the privilege of calling for a recount, and, in the event of a tie vote, it shall assume the responsibility of determining the procedure for selection of the candidate to be declared elected.*	(b) No (b) section.

Article IV, Section IV. Election, Tenure of Office, and Convention

Directors shall be elected by a *plurality of the votes cast by members of the Association. Those candidates declared elected to membership on the Board of Directors shall be the required number of nominees receiving the largest number of votes cast in the annual election as described in Section III, (b) of Article III.* They shall assume the duties . . . *where* the certificate *of* organization is recorded.	Directors shall be elected by a majority vote of the members present at any annual meeting. They shall assume the duties . . . when the certificate or organization is recorded.

Article V, Section II. Nominating Committee

(a) *Promptly following the Annual meeting of the association, the Executive Committee shall appoint a committee of five (5) to be known as the NOMINATING COMMITTEE; (b) The membership of this Committee shall be so selected as to present a balanced representation of the Association according to sectional, geographical, and level-of-teaching areas distribution; (c) The Chairman of the Committee shall be designated from this group by the Executive Committee; (d) The term of service on the Committee shall be one year; (e) The Committee shall nominate two candidates for the office of President and two candidates for the office*	The Nominating Committee shall consist of five (5) members chosen by the Executive Committee.

of Vice-President, and twice as many candidates as there are positions to be filled on the Board of Directors; (f) All nominees must be properly qualified members of the Association currently in good standing; (g) The Chairman shall provide for mailing to the membership necessary pictures and professional biographies of the nominees; (h) The Chairman of the Committee and the Secretary of the Association shall have the joint responsibility of making the official count of all votes cast in the annual election. They shall provide the President of the Association prior to the time of the annual meeting of the Board of Directors, with a report, over their signatures of the results of the official count.

Delete:

ARTICLE II. SECTION VII. PROXIES: All members entitled to vote may cast their votes in person or through a duly accredited proxy.

Change numbering:
ARTICLE II. SECTION VIII. NOTICE OF MEETINGS
Should be changed to read:
ARTICLE II. SECTION VII. NOTICE OF MEETINGS

PROBLEM DEPARTMENT

CONDUCTED BY MARGARET F. WILLERDING

San Diego State College, San Diego, Calif.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution or proposed problem sent the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the Department desires to serve his readers by making it interesting and helpful to them. Address suggestions and problems to Margaret F. Willerding, San Diego State College, San Diego, Calif.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Solutions should be in typed form, double spaced.

2. Drawings in India ink should be on a separate page from the solution.

3. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

4. In general when several solutions are correct, the one submitted in the best form will be used.

LATE SOLUTIONS

2546, 2552. *J. Byers King, Denton, Md.*

2549. *Felix John, Philadelphia, Pa.*

2559, 2560, 2561. *Robert A. Morris, Philadelphia, Pa.*

2563. *Proposed by Cecil B. Read, University of Wichita, Wichita, Kansas.*

A problem frequently found in algebra books a generation ago was: At what time after a specified hour will the hour and minute hands of a clock be together? The modern electric clock often has an hour, a minute, and a second hand; at what time after 12 o'clock will the three hands again be together?

Solution by the Proposer

If, after the hands are together, x = the number of minute divisions covered by the minute hand, $x/12$ = the number of minute spaces covered by the hour hand, and when they are first together again, $x = 60 + x/12$. It readily follows that the minute and hour hands are together at 1:05 5/11; 2:10 10/11; 3:16 4/11; 4:21 9/11; 5:27 3/11; 6:32 8/11; 7:38 2/11; 8:43 7/11; 9:49 1/11; 10:54 6/11; and again at 12. At each of these positions the second hand must indicate a fractional part of a minute, for example at the first time the second hand must indicate 5/11 of a minute, and hence will fall 27 3/11 minute divisions after 12. It is readily seen that the position of the second hand fails to agree with the position of the hour and minute hands until all three hands again fall at 12:00.

Solutions were also offered by: Curtis Boyd Benning, Holland, Mich.; Felix John, Philadelphia, Pa.; J. Byers King, Denton, Md.; Walter R. Talbot, Jefferson City, Mo.; and Alan Wayne, Baldwin, N. Y.

2564. *Proposed by A. R. Haynes, Tacoma, Wash.*

1. Show that the locus of the intersections of the normals at the ends of a system of parallel chords of the parabola $y^2 = 4ax$ is a straight line.
2. Find the relationship which exists between the slope of the locus and the slope of the parallel chords.
3. (a) When the angle which the locus makes with the x-axis is $3\pi/4$, find the angle which the parallel chords make with the x-axis.
(b) When the angle which the parallel chords make with the x-axis is $2\pi/3$, find the angle which the locus makes with the x-axis.

Solution by the Proposer

Let $P_1(x_1, y_1)$ and $P_2(x_2, y_2)$ be the ends of one of the system of parallel chords. Since P_1 and P_2 are on the curve $y^2 = 4ax$.

$$y_2^2 - y_1^2 = 4a(x_2 - x_1) \text{ or}$$
$$y(y_1 + y_2) - 4ax - y_1y_2 = 0.$$

Hence the slope of P_1P_2 is $m = 4a/y_1 + y_2$. (1)
If Q is the midpoint of P_1P_2,

$$Q\left(\frac{x_1+x_2}{2}, \frac{y_1+y_2}{2}\right) \quad \text{and} \quad 2y_q = y_1 + y_2 \tag{2}$$

therefore

$$m = 4a/2y_q \quad \text{and} \quad y_q = 2a/m. \tag{3}$$

Hence y_q is constant for the system of parallel chords and the locus is a straight line.

The normal to $y^2 = 4ax$ from P_0 is

$$(y - y_0) + y_0/2a(x - x_0) = 0$$

where

$$x - x_0 = x - y_0^2/4a.$$

This is a cubic equation with the squared term missing.

Let (h, k) be the intersection of the normals from P_1, P_2, and P_3 the intersection of the locus with the parabola. Since three normals can be drawn to the parabola, the locus is the third normal from (h, k).

If y_1, y_2, y_3 are the roots,

$$y_1+y_2+y_3=0. \tag{4}$$

But, by (2),

$$2y_q=y_1+y_2$$

Therefore

$$y_3=-2y_q.$$

Hence for a system of parallel chords the sum of the two ordinates is constant and the normals at the point meet on the normal of a fixed point, the ordinate of which added to the sum of their ordinates is zero.

The sub-normal for the parabola $y^2=4ax$ is a constant, $-2a$; therefore the slope of the fixed normal (the locus) at $P_3(x_3, y_3)$ is

$$\tan\theta=y_3/-2a=2/m, \quad \cdot y_3=-(y_1+y_2)=-2p_q=-4a/m.$$

Therefore the product of the slopes of the parallel chords and the locus mm_3 is the constant 2.

When θ is

$$3\pi/4, \quad \tan\theta=-1 \text{ and } m=-2; \quad \tan^{-1}(-2)=116°33'30''$$

When

$$\tan^{-1}(m)=2\pi/3, \quad m=-\sqrt{3} \text{ and } m_3=-2/\sqrt{3}, \quad \tan^{-1}(-2/\sqrt{3})=130°53'54.5''$$

2565. *Proposed by Julius Sumner Miller, El Camino College, El Camino College, California.*

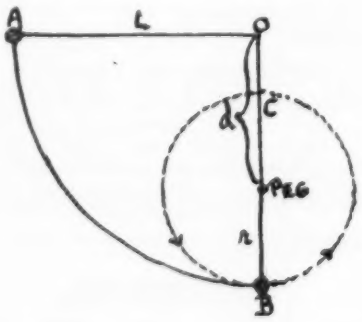
A particle attached to a fixed point by a string of length L which is taut and horizontal is released and the string, when passing through the vertical, catches a peg at depth d below the fixed point. Find d if the particle then just makes a complete revolution.

Solution by the Proposer

The potential energy of the particle at A is mgL.

The velocity of the particle at B is $\sqrt{2gL}$. (From $v_2=2gL$).

The kinetic energy of the particle at B is $\frac{1}{2}m\times 2gL$.



The critical velocity at C (that is necessary to just keep the string taut as it circles the *peg*) is given by $v=\sqrt{gr}$. (Gotten from $mv^2/r=mg$).

By energy considerations then,

$$KE_B=KE_C+PE_C.$$

Thus

$$\tfrac{1}{2}m\times 2gL=\tfrac{1}{2}m\times gr+mg\times 2r.$$

From which $r=\frac{2}{5}L$. Whence the peg is at a depth $\frac{3}{5}L$ below the fixed point 0.

INTERESTING EXTENSION: Examine the situation if the string is *elastic*, modulus, k, say, unstretched at A. When at B, remember, the added tension $(mg+mv^2/r)$ gives a new L!

2566. *Proposed by Cecil B. Read, Wichita, Kansas.*

A knight and a pawn are placed at random on a chess board; if it is the knight's move what is the chance that it can take the pawn with that move?

Solution by W. R. Talbot, Jefferson City, Missouri

The array below represents half a chess board and shows the number of squares commanded by a knight in each position.

2	3	4	4	4	4	3	2
3	4	6	6	6	6	4	3
4	6	8	8	8	8	6	4
4	6	8	8	8	8	6	4

It is readily observed that there are

	Positions	Commanding squares
A	4	2
B	8	3
C	20	4
D	16	6
E	16	8

There are 4/64 chances that knight will land in position A, and once there, he has 2/63 chances of capturing the pawn. The probability of occurrence of both events is

$$\frac{4}{64}\cdot\frac{2}{63}.$$

This leads to

$$\frac{4}{64}\cdot\frac{2}{63}+\frac{8}{64}\cdot\frac{3}{63}+\frac{20}{64}\cdot\frac{4}{63}+\frac{16}{64}\cdot\frac{6}{63}+\frac{16}{64}\cdot\frac{8}{63}=\frac{1}{12}$$

There is 1 chance in 12 that the knight will ca.ture the pawn.

Solutions were also offered by: Julius H. Braun, San Diego, Calif.; Curtis Boyd Menning, Holland, Mich.; W. R. Smith, Passe a Grille Beach, Fla.; and the proposer.

2567. *Submitted by Brother Felix John, Philadelphia, Pa.*

Show that

$$\log_e\frac{(1+x)^{1/2(1-x)}}{(1-x)^{1/2(1+x)}}=x+5x^3/2\times 3+9x^5/4\times 5+13x^7/6\times 7+\cdots$$

Solution by the Proposer

1. The left-hand member $=\frac{1}{2}(1-x)\log_e(1+x)-\frac{1}{2}(1+x)\log_e(1-x)$
2. which equals $\frac{1}{2}(1-x)(x-x^2/2+x^3/3-x^4/4+\cdots)-\frac{1}{2}(1+x)(-x-x^2/2-x^3/3-x^4/4-\cdots)$
3. which equals $\frac{1}{2}(1-x)(x-x^2/2+x^3/3-x^4/4+\cdots)+\frac{1}{2}(1+x)(x+x^2/2+x^3/3+x^4/4+\cdots)$
4. $=(x+x^3/3+x^5/5+x^7/7+\cdots)+\frac{1}{2}(-x^2+x^2+x^3/2+x^3/2-x^4/3+x^4/3+x^5/4+x^5/4-\cdots)$

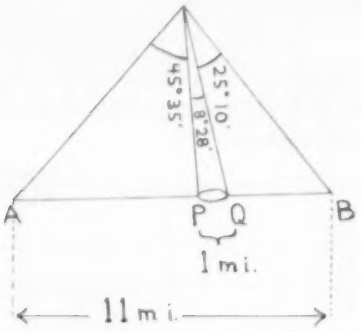
5. $=x+(x^3/2+x^3/3)+(x^5/4+x^5/5)+(x^7/6+x^7/7)+\cdots$
6. $=x+5x^3/2\times3+9x^5/4\times5+13x^7/6\times7+\cdots$

NOTE: This is Miscellaneous Example no. 49, from Hall and Knight's, *Higher Algebra*, p. 494.

2568. *Proposed by A. R. Haynes, Tacoma, Wash.*

An island PQ, one mile wide, lies in a direct line between two cities, A and B, on opposite shores of a river. From O, a point up river, the channels AP and BQ subtend angles of 45° 35′ and 25° 10′, respectively, while the island subtends an angle of 8° 28′. The cites are known to be 11 miles apart. Find the widths of the channels, the channel adjacent to A being observed to be the greater.

Solution by Robert A. Morris, Philadephia, Pa.



Let the width of channel AP be X and BQ be $(10-X)$. Then by cross-ratio:

$$\frac{AQ\cdot PB}{AB\cdot PQ}=\frac{\sin\angle AOQ\cdot\sin\angle POB}{\sin\angle AOB\cdot\sin\angle POQ}$$

Substituting:

$$\frac{(1+X)(11-X)}{1\cdot11}=\frac{\sin 54°03'\cdot\sin 33°38'}{\sin 79°13'\cdot\sin 08°28'}$$

$$11+10X-X^2=34.1023$$

$$X^2-10X+23.1023=0$$

$$X=6.377 \qquad X=3.623$$

Since channel AP was given as the larger,

$$AP=6.377$$

$$BQ=3.623$$

Solutions were also offered by W. R. Smith, Passe a Grille Beach, Fla.; and the proposer.

STUDENT HONOR ROLL

The Editor will be very happy to make special mention of classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

Editor's Note: For a time each student contributor will receive a copy of the magazine in which his name appears.

For this issue the Honor Roll appears below.

2563, 2566. *Robert A. Morris, Philadelphia, Pa.*

2563, 2566. *Nathaniel Queen, Brooklyn, N. Y.*

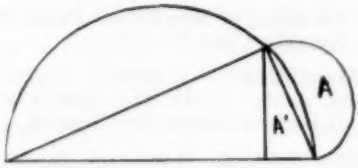
2563, 2566. *George Nebus, Glenside, Pa.*

EDITOR'S NOTE: The Editor of The Problem Section is always interested in receiving new problems for solution. If you have any interesting and/or original problems please send them to the Problem Section of SCHOOL SCIENCE AND MATHEMATICS.

PROBLEMS FOR SOLUTIONS

2587. *Proposed by Brother T. Brendan, St. Mary's College, Calif.*

On page 392 of the Dover edition (1955) of the classical work, "Monographs of Topics in Modern Mathematics," occurs this paragraph and figure, by the mathematician David Eugene Smith; ". . . He (Hippocrates) proved that if semicircles be described upon the sides of an isosceles right triangle, as shown in the figure, the lune A will equal the triangle A'. The proposition is easily generalized for the scalene right triangle." Check the geometrical assertions of this paragraph.



2588. *Proposed by Julian H. Braun, San Diego, Calif.*

Solve $\sin\theta \cdot \sin 2\theta = \sin\theta/2 \cdot \sin 11/2 \cdot \theta$ for all values of θ between 0° and 180°.

2589. *Proposed by Cecil B. Read, Wichita, Kans.*

A square is divided into 16 equal squares by horizontal and vertical lines. There are available 16 counters, four each of white, black, red, and yellow. In how many ways can the counters be placed on the squares, a counter to each square, without having the same color in the same vertical or horizontal row?

2590. *Proposed by Brother Felix John, Philadelphia, Pa.*

Show that the roots of the equation

$$x^4 - px^3 + qx^2 - rx + r^2/p^2 = 0$$

are in proportion.

2591. *Proposed by L. M. Ridder, Exeter, N. H.*

Given 0, define both 1 and 2.

2592. *Proposed by A. R. Haynes, Tacoma, Wash.*

How far from the wall of a house must a man, whose eye is 5 ft from the ground, stand so that a window, 5 ft. high with its sill 9 ft. from the ground, may subtend the greater arc?

BOOKS AND PAMPHLETS RECEIVED

A HANDBOOK OF HARD METALS, by W. Dawihl. Cloth. Pages viii+162. 15×24 cm. 1956. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $10.00.

A SHORT DICTIONARY OF MATHEMATICS, by C. H. McDowell. Cloth. Pages xiii+64. 11×18.5 cm. 1957. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $2.75.

A STUDY OF THE SCIENCE AND MATHEMATICS COURSES BY THE 1956 SENIOR CLASS, AND THE NUMBER OF SENIORS WHO PLANNED TO SPECIALIZE IN THE SCIENTIFIC FIELDS IN THE ACADEMIC HIGH SCHOOLS IN NEW YORK CITY, by Samuel Schenberg, *Supervisor of Science, Board of Education, New York City.* Paper. 31 pages. 20.5 × 25.5 cm. 1957. Board of Education of the City of New York, 110 Livingston Street, Brooklyn 1, N. Y.

BIOLOGY, by Elsbeth Kroeber, *formerly, First Assistant in Biological Science and Administrative Assistant at Midwood High School, Brooklyn, N. Y.;* Walter H. Wolff, *Principal, William Cullen Bryant High School, Queens, N. Y.;* and Richard L. Weaver, *Associate Professor of Conservation, School of Natural Resources, University of Michigan.* Cloth. Pages viii+608. 16×23.5 cm. 1957. D. C. Heath and Company, 285 Columbus Avenue, Boston 16, Mass. Price $4.68.

EARLY ELECTRICAL MACHINES, by Bern Dibner. Paper. 57 pages. 21×27.5 cm. 1957. Burndy Library, Norwalk, Conn. Price $1.50.

ELECTRICITY AND MAGNETISM, by J. Newton, *Senior Lecturer in Physics, Northampton Polytechnic, London.* Cloth. 613 pages. 13×19 cm. 1956. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $10.00.

FREE AND INEXPENSIVE LEARNING MATERIALS. Paper. Pages vii+264. 14× 21.5 cm. 1957. Division of Surveys and Field Services, George Peabody College for Teachers, Nashville 5, Tenn. Price $1.00.

FREQUENCY MODULATION RECEIVERS, by J. D. Jones, Cloth. Pages ix+114. 13.5×21.5 cm. 1957. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $6.00.

GALACTIC NEBULAE AND INTERSTELLAR MATTER, by Jean Dufay, *Director of the Lyon and Haute-Provence Observatories.* Translated by A. J. Pomerans. Cloth. 352 pages. 15×23 cm. 1957. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $15.00.

INSIGHT, A STUDY OF HUMAN UNDERSTANDING, by Bernard J. F. Lonergan, S.J., *Professor at the Gregorian University, Rome.* Cloth. Pages xxx+785. 14× 21.5 cm. 1956. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $10.00.

LIGHT, VEGETATION AND CHLOROPHYLL, by J. Terrien, G. Truffaut, and J. Carles. Translated by Madge E. Thompson. Cloth. 228 pages. 12×18.5 cm. 1957. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $6.00.

LIVING CHEMISTRY, SECOND REVISED EDITION, by Maurice R. Ahrens, *Professor of Education, University of Florida;* Norris F. Bush, *Director of Special Education and Pupil Personnel, Denver;* and Ray K. Easley, *Principal, Westwood School, Denver.* Cloth. Pages viii+582. 21×25.5 cm. 1957. Ginn and Company, Statler Building, Boston 17, Mass. Price $5.28.

MAN AGAINST GERMS, by A. L. Baron, Ph.D. Cloth. 320 pages. 13.5×20 cm. 1957. E. P. Dutton and Co., Inc., 300 4th Avenue, New York 10, N. Y. Price $4.50.

MATHEMATICS FOR EVERYMAN, by Egmont Colerus. Cloth. Pages xi+255. 12.5×19 cm. 1957. Emerson Books, Inc., 251 West 19th Street, New York 11, N. Y. Price $3.95.

MATH PROBLEMS FROM INDUSTRY. Paper. Unpaged. 21.5×28 cm. 1956. Educational Services, Department of Public Relations, Chrysler Corporation, P. O. Box 1919, Detroit 31, Mich.

MYSTERIES OF SCIENCE, by John Rowland, Cloth. Pages ix+214. 14×21.5 cm. 1957. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $6.00.

NIELS HENRICK ABEL, MATHEMATICIAN EXTRAORDINARY, by Oystein Ore. Cloth. 277 pages. 15×23 cm. 1957. University of Minnesota Press, Minneapolis, Minn. Price $5.75.

PHYSICAL SCIENCE FOR LIBERAL ARTS STUDENTS, by Hugo N. Swenson, Ph.D., *Professor of Physics, Queens College;* and J. Edmund Woods, Ph.D., *Professor of Physics, Queens College.* Cloth. 333 pages. 19×25.5 cm. 1957. John Wiley and Sons, Inc., 440 4th Avenue, New York 16, N. Y. Price $6.50.

PHYSICS CALCULATIONS, by Russell H. Johnson, *Physics Department, Baltimore City College.* Paper. Pages vi+144. 13×18.5 cm. 1957. College Entrance Book Company, 104 5th Avenue, New York 11, N. Y. Price $.65.

RADIO AIDS TO AIR NAVIGATION, by J. H. H. Grover, M.I.N. Cloth. Pages x+138. 14×21.5 cm. 1957. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $6.00.

SEAFARERS AND THEIR SHIPS, Prepared by the Ministry of Transport and Civil Aviation and the Central Office of Information, Great Britain. Cloth. 96 pages. 13.5×21 cm. 1956. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $3.50.

SCIENTISTS AND ENGINEERS IN GREATER KANSAS CITY: A SURVEY OF DEMAND AND SUPPLY FACTORS, by Frank T. Stockton. Paper. 47 pages. 15×23 cm. June, 1957. Scientific and Technical Manpower Study for Greater Kansas City, 1411 Walnut Street, Kansas City 6, Mo.

SOLID GEOMETRY, by Hugo Mandelbaum, *Associate Professor of Mathematics, Wayne State University,* and Samuel Conte, *Associate Professor of Mathematics, Wayne State University.* Cloth. Pages vi+261. 13.5×20 cm. 1957. The Ronald Press Company, 15 East 26th Street, New York 10, N. Y. Price $4.00.

TEACHING SCIENCE IN THE SECONDARY SCHOOL, by R. Will Burnett, *Professor of Science Education, University of Illinois.* Cloth. Pages xii+371. 17.5×25.5 cm. 1957. Rinehart and Co., Inc., 232 Madison Avenue, New York 16, N. Y. Price $5.25.

THE LIVING ROCKS, Preface by André Maurois, Commentary by Geoffrey Grigson, and Photographs by Stévan Célébonovic; Translated by Joyce Emerson and Stanley A. Popcock. Cloth. 95 pages. 21×28.5 cm. (no date). Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $6.00.

V.H.F. TELEVISION TUNERS, by D. H. Fisher, A.M.I.E.E. Cloth. Pages vii+136. 14×21.5 cm. 1957. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $6.00.

YOUR FUTURE IS WHAT YOU MAKE IT. Paper. 30 pages. 21.5×15 cm. 1954. National Association of Manufacturers, 2 East 48th Street, New York 17, N. Y. Free.

YOUR OPPORTUNITIES IN INDUSTRY AS A TECHNICIAN. Paper. 30 pages. 15× 21.5 cm. 1957. National Association of Manufacturers, 2 East 48th Street, New York 17, N. Y. Free.

YOUR OPPORTUNITIES IN SCIENCE AND ENGINEERING. Paper. 30 pages. 15× 21.5 cm. 1956. National Association of Manufacturers, 2 East 48th Street, New York 17, N. Y. Free.

BOOK REVIEWS

ALGEBRA IN EASY STEPS, Third Edition, by Edwin I. Stein, *Leeds Junior High School, Philadelphia, Pennsylvania.* Cloth. Pages vi+298. 19.5×26 cm. 1956. D. Van Nostrand Company, Inc., 120 Alexander Street, Princeton, N. J. Price $2.32.

The fact that this first-year algebra text is now in its third edition shows that it meets a need. Its emphasis is placed on the formula, its language and its application. The approach to a new topic is so gradual, that it should give the student a sense of security.

Each unit is organized under the following headings:

I. Aim
II. Procedure
III. Sample Solutions
IV. Diagnostic Test
V. Related Practice Examples

Frequently "Applications" also are included. At the end of the chapter units follows a Review of the Unit and a Cumulative Review.

The motivating introductory material is good. However, the print is small and there is a certain monotony in the sameness of presentation—no color, no framed rules. No pictures of real life applications are found, only sketches of thermometers (page 50) and geometric figures (pp. 81, 87 etc.)

Should the "transposition method" be taught at this stage? Many teachers object to this violently; but Mr. Stein introduces it on page 111: "Moving a number from one side of an equation to the other side and changing its sign is another way of applying the addition and subtraction axioms."

However, it should be said that Unit Four on Equations p. 30–51, stresses the "Axion Method."

Many teachers prefer that the unit on "Positive and Negative Numbers" should *precede* rather than follow the unit on "Equations." This author does not think so. He develops the meaning of signed numbers *after* the unit on equations, namely on pages 53 to 73.

Exercise 40 aims at the solution of general word problems. The procedure outlined on p. 119 is good, namely that attention is called to the importance of checking the *problem, not* the equation. The procedure failed to indicate, however, that merely "solving the equation" will not yield all required conclusions. Also, the method of presenting data in the form of "boxed notation" has been entirely ignored in this unit.

No greater help can be given to students in the study of verbal problems than instruction in how to present the notation in tabular form. This method is presented rather inadequately on pp. 186–190.

The unit on "Special Products and Factoring" has ample practice exercises. The teacher will be pleased with this unit, as well as the units on fractions, pp. 146–170.

I like the Introduction to Unit Ten, although I believe all definitions should be in heavy type. On page 171 is a good, correct definition of fractional equations: "A fractional equation is one which contains the unknown in one or more of the denominators."

The Unit on Direct and Inverse Variation is weak.

The procedure on how to solve a quadratic equation by completing the square is clearly presented in eight steps. But why must you "factor the perfect trinomial square on the left member" before you "find the square root of both members"?

One of the best features of *Algebra in Easy Steps* is its clear, consistent presentation of topics and ample practice materials. No supplementary work book is needed. The fact that the printed page seems crowded and that the print is small is less noticeable after the student has become adjusted to this pattern.

ANTON S. RICHERT
East High School
Wichita, Kansas

ATOMIC QUEST, A Personal Narrative; by Arthur Holly Compton, *Distinguished Professor of Philosophy, Washington University, St. Louis.* Cloth. 370 pages. 14.3×20.6 cm. 1956. Oxford University Press, 114 Fifth Avenue, New York 16, N. Y. Price $5.00.

There was more than classified information behind those closed doors of Argonne Laboratories, Clinton Engineering Works, Manhattan District, Hanford Engineering Works and the Metallurgic Project. There was a "know how" as well as a "know what" under guard. That "know how" was the distillation from countless unrecorded exchanges of technical ideas between the men on the inside. When this human participant-aspect of the "know what" fails to reach the outsider there is induced a sort of out-of-this-world attitude on his part. This "personal narrative," while replete with information, also includes accounts of that exchange between the performers as well as their achievements. Such an inclusion helps the reader to get a sense of, "You are there."

In a sense, this is an autobiography without a biographic intent. While it gives but a limited segment of the author's total fruitful scientific activity, yet by using biography's pattern it incites reader interest. On the other hand the pronoun "I" is not intrusive. The personal glimpses are beamed toward the assessment of the activities of his scientific team-mates. Activities? Yes. But often the heart-search and emotional antecedents of what was done add suspense and drama to what must have been the boresome tedium of repeated gropings into they knew not what. Fortunately none of the hazardous probes punctuated the error by explosive violence. Sensing such uncertainty may have been, in part, back to their expressed concern over the long-range significance of this incredulous nuclear energy. While the author was intimately associated with these tensions and ethical concerns his report nevertheless has the qualities of a dispassionate objective recital.

This is number ten of books on "atomic" energy that have passed before this reviewer during the past ten years. Judging from them and published reports elsewhere the public's concern over atomic power has undergone a sort of three-stage change. First interest was with "What it did to those Japanese cities." The second concern was publicized by the Geneva International Conference on the Peaceful Uses of Atomic Energy. This time the accent was on "What can it do for the world?"

Currently the focus seems to have shifted to "What may I expect it to do to me?" Its biological potential has been rather implicit from the first. But another aspect of this personal effect is emerging into John Doe's consciousness. More explicitly put, "What is this new energy-entity doing to my mental or philosophical attitude toward my universe?"

The Atomic Quest is the first, in this reviewer's reading, to give explicit attention to this aspect of "men and atoms." In fact the author's organization of his narrative reveals that as a conscious intent. He sections his biography into Vision, Faith, Work, Choice and Hope. In the last two he gives arresting, if not fully comforting, counsel. He shares the bases upon which he, personally, has met the issue. Even here his assessment has the ear-marks of objectivity. However, some of his operationally-minded fellow-scientists may exhibit slightly lifted eyebrows

when his logic drafts aid from the semi-mystic philosophy related to religions. There are probably many others, however who will join with this reviewer in gratitude to him for venturing to add that dimension to his "Atomic Quest."

B. CLIFFORD HENDRICKS
457 24th Avenue
Longview, Washington

COTTONTAIL RABBIT, by Elizabeth and Charles Schwartz, *Biologists, Missouri Conservation Commission.* Cloth. 46 pages. 14×20 cm. 1957. Holiday House, 8 West 13th Street, New York 11, N. Y. Price $2.00.

In recent years Holiday House has published a series of excellent "Life-Cycle" stories for children. *Cottontail Rabbit* is the latest addition to this series. *Cottontail Rabbit* is not merely the story of the life history of one animal. Rather, it describes the entire ecological community in which the rabbit lives. It gives an excellent description of the food chain in such a community, and points out the place of the rabbit in this chain.

The story centers around the life of one female rabbit and her problems in maintaining life. Yet, it carefully avoids the personification of the rabbit. The struggle for existence is tactfully, yet scientifically outlined.

The authors of this book are staff biologists with the Missouri Conservation Commission, and hence are well-qualified to write a scientifically accurate book. In addition to the excellent text, the book is made doubly appealing by the very attractive illustrations drawn by Mr. Schwartz.

The low reading level and high interest level of the book should enable a teacher to use it most effectively with superior young children and retarded older children, as well as "average" youngsters. Certainly, it should be an excellent addition to any elementary school library or classroom.

GEORGE G. MALLINSON
Western Michigan University
Kalamazoo, Michigan

FUNDAMENTAL MATHEMATICS, by Thomas L. Wade, *Professor of Mathematics, The Florida State University,* and Howard E. Taylor, *Associate Professor of Mathematics, The Florida State University.* Cloth. Pages xiv+380. 14.5×23 cm. 1956. McGraw-Hill Book Company, Inc. 330 West 42nd Street, Hew York 36, N. Y. Price $4.75.

This is a text for use with those students "who lack either preparation or motivation for the study of the usual course in first-year college mathematics." The material presented has a wide range of difficulty hence can be used with any amount of preparation up to the level of College Algebra. Students who have successfully completed a course using most of this text should have the necessary background for a strong course in College Algebra and if highly successful perhaps could advance to Trigonometry and Analytical Geometry.

The introductory chapter widens the student's information concerning our number system while the following two chapters provide a sound basis for the fundamental operations. The following chapters cover topics often considered in an algebra text but with a different introduction based on information given in earlier chapters. Some introductory work in trigonometry, business mathematics, and statistics is also included. No material concerning algebra of sets is presented. Some parts of the test lists rules but it should be very easy to make sure the student understands the basis for the rules. Anyone using this text should be able to build a course based on basic generalizations rather than rules if that is desired.

The number of exercises presented should allow for variation in assignment according to the ability of a class. Answers are given for the odd numbered exercises. Suggested lesson assignments are given for a course in fundamental mathematics, a course for general education, and for a course as preparation for trigonometry and analytic geometry.

Anyone considering textbooks for a course in mathematics for general education or for a course in introductory algebra should thoroughly examine this text.

DR. OTHO M. RASMUSSEN,
Chairman, Department of Mathematics
University of Denver

GUIDES TO STRAIGHT THINKING, by Stuart Chase. Cloth. Pages x+212. 14×21 cm. 1956. Harper and Brothers, 49 East 33rd Street, New York 16, N. Y. Price $3.50.

He who would care to know *how much to accept* of "what the senator on the floor, the critic of the senator, the writer of editorials, the omniscient voices on the radio, the attorney in the courtroom, the campaign orator, the copy writer of Madison Avenue or the Moscow propaganda mill are trying to make him believe" will find, in this book, explicit aids to that end. Its ministry is both to greater certainty for the listener and to improved precision and reasonableness for the one who contributes to communication.

The author gives special attention to thirteen fallacies met in the day-to-day conversations and writings of common folks. He concedes there may be more. In fact he lists twenty-two which he abstracted from the Encyclopedia Britannica, in the Appendix.

Thirteen of the twenty-two chapters of the book are devoted to those selected fallacies. His pattern of treatment amplifies a non-technical statement of each by illustrative anecdotes selected from daily life. Whether read by one casually following an interesting narrative or by a person in need of navigational guidance through a smoke screen or verbiage, one will here find reward.

The thirteen chapters, one for each fallacy, are preceded by four that describe the development of logic by the Greeks; its revision and canonization by the Schoolmen of the Middle Ages; Galileo's challenge of that canon and finally modern science's shift of focus from *form* of logic to the *primacy of facts*. Attention to facts is both for premises and as pragmatic checks for logic's end-products.

Titles of the thirteen chapters are: Overgeneralization; Thin entering wedge (Super-extrapolation); Getting personal (Name calling); "You're another" (Matching defects); Cause and effect (Time sequence logic); False analogies; Wise men may be wrong (An authority??); "Figures prove"; Appeal to the crowd (Everybody's doing it); Argument in circles; "Self-evident truths"; Black or white (Either or?); and Guilt by association.

In the last chapters: propaganda is analyzed. (In it, fallacies are cynically used and added specials such as Scapegoats, Hero and Martyr appeals and Big Lie techniques are listed.) Courtroom procedures are scanned to find their "magnificent safeguards—not always in operation" and "Town Meetings" turn up a wealth of the fallacies listed.

In a brief last chapter the author tactfully ventures that possibly the reader "may discover room for improvement (perhaps, only a little) in his own reasoning apparatus." However that may be, optimism breaks through the fallacy-probing in this closing sentence: "The time may be nearer than we imagine when we shall break through the mental barriers (to straight thinking) as a jet breaks through the barrier to sound."

For the serious reader there are many footnote references, a seventeen titled bibliography and a three-page double-columned index. It is obvious that this book is a desirable navigational aid to students of the deductions of mathematics or the inductive processes of the scientists.

B. CLIFFORD HENDRICKS

PHYSICS—A MODERN APPROACH, by L. Paul Elliott, *Late Professor of Physical Sciences, University of Florida*, and William F. Wilcox, *Assistant Professor of Physics, Eastern Michigan College*. Cloth. Pages xi+658. 16.5×23.5 cm. 1957. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $5.12.

The words "Modern Approach" might be questioned, but the fact that this

book has a different approach is apparent from the first page. To the teacher looking for the physics textbook for use with the superior students this could be the answer. The book concentrates "on developing the fundamental principles of physics" rather than the storybook presentation of everyday happenings and trying to deduce the principles of physics.

It is a large book, consisting of 19 units and 53 chapters. Each unit starts with a problem, either one the student has faced, or one some scientist has faced. The difference in this book is apparent in the first unit—The Beginnings of Physics. The first chapter deals with the beginning experimental physics. The second chapter presents the various methods used in the search for scientific facts. Chapter four presents the mathematical tools used in physics. This gives a good basic review of the mathematical processes. In the subsequent units, it presents the problems facing any hypothetical solution as the problem of explaining light transmission—wave vs quantum theory.

The illustrations are meaningful and pertinent to the text. The use of a second color in the line drawings emphasizes the pictured facts. The important principles are stated in red ink. At the end of each chapter is a complete summary, questions for review, and problems. Also, the project list is very challenging for all students. "Readings you will enjoy" lists books the teacher can recommend to the school librarian for purchase. The appendix consists of the derivations of the formulae explained and used in the text.

For the teacher looking for a text which teaches physics rather than describing or talking about it, you must examine this book. If this is the "Modern Approach" the reviewer likes it, but it also is a good, solid, fundamental approach to teaching physics which will provide the student with principles to solve problems on his own.

E. Wayne Gross
University School
Bloomington, Indiana

Plane Trigonometry, Third Edition, by Alfred L. Nelson, *Professor of Mathematics*, and Karl W. Folley, *Professor of Mathematics, Wayne University, Detroit, Michigan*. Cloth. Pages xi+195+134. 15×23.5 cm. 1956. Harper and Brothers, 49 East 33rd Street, New York 15, N. Y. Price $3.50.

This is the third edition of a text by the same authors previously published under the title of *Plane and Spherical Trigonometry*. This text must be classified as a traditional presentation even though changes have been incorporated. The chief change is the omission of spherical trigonometry. The authors also claim these other changes: the reverting back to the original edition's offering of the general angle before the acute angle; earlier introduction of logarithms; a modified classification of oblique triangles to help clarify the ambiguous case; an improvement in the presentation of the question of the non-existent functions of the quadrantal angles; a rewritten chapter on complex numbers; and the great majority of the exercises being completely new.

Strong points of the text are the inclusion of the answers to odd numbered exercises in the back, 135 pages of tables in the back (including 5-place logarithm and logarithms of the functions tables), the presence of a large number of exercises throughout the book, and the fact that the material is well-written and easily read.

Some may be opposed to the deletion of the spherical trigonometry chapter. Other opposition would have to come from those opposed to a traditional presentation.

Ralph W. Johnson
Lyons Twp. High School
La Grange, Illinois

Filmstrips—Whys of Elementary Science, Set I. Consists of four colored filmstrips. Filmstrip House, 347 Madison Avenue, New York 17, N. Y. Price $20.00 per set; $6.00 per filmstrip.

Jim and Susan, two young children, find out the answers to four simple science questions. These are: *Why does it rain? Why do we have wind? Why do we have warm and cold days? Why do we have night and day?* These are the titles of the filmstrips.

Jim and Susan perform experiments using materials found in their everyday living to help them find their answers. The experiments are of such a nature that children in all classrooms could perform them.

Jim and Susan show the class how water evaporates by washing the chalkboard and watching the wet surface become dry again. They hold a cold plate in the cloud of steam from their mother's teakettle and notice drops of water collect on the plate. They see that when the bits of water meet something cooler they become drops of water.

As Jim and Susan walk home on a windy day, they watch many things the wind is doing. Realizing that wind is moving air, they wonder if heat makes the air move. They find out by putting balloons over the necks of two empty milk bottles. They put one bottle in a pan of water and place it on the stove to heat. As the water heats, the balloon on the milk bottle begins to fill out while the balloon on the unheated bottle remains limp. They learn what it means when we say, "air expands when it is warmed."

Jim and Susan watch the moon and the sun. Their father helps the children find out what happens to the sun at night by doing and experiment with a beach ball and a light bulb.

Jim and Susan learn about why we have warm and cold days through their discoveries at the beach. They discover: (1) the longer the sun shines, the warmer the land becomes; (2) clouds shade the earth, making it cooler; (3) water makes climates warmer in winter and cooler in summer.

The number of frames to each filmstrip varies, but all have between 25–30 frames. The colors are pleasing and the art is realistic. Miss Loretta Ott, Principal of Hall Public School, Grand Rapids, Michigan, is the principal consultant for these filmstrips. The vocabulary and pictures make these filmstrips excellent for use in the primary grades.

LUCILE C. GROSS
McCalla School
Bloomington, Indiana

CHEMICAL AND PHYSICAL SUPPORT STANDS RESTYLED BY CENTRAL SCIENTIFIC CO.

Central Scientific Company has restyled its line of chemical and physical support stands to improve appearance and efficiency for laboratory use.

The cast iron bases, finished in attractive blue hammertone, give weight where it is needed for greater stability. They come in the rectangular type for chemistry, and the Harrington V-shape for general physics. The rectangular bases have reinforced bottoms to prevent warping and both types are ground flat to eliminate wobble.

Offered in several convenient sizes, the new Cenco line of bases is designed so each type may be stacked together to save storage space.

The aluminum-alloy rods used are lighter in weight which gives the support stand an even lower center of gravity for better stability. The rods are offered in a wide variety of lengths, from 6 inches to 50 inches, and diameters of $\frac{3}{8}$, $\frac{1}{2}$ and $\frac{3}{4}$ inches.

Bases and rods are listed separately to permit a selection of any combination for any particular laboratory need.

For further information write to Central Scientific Company, 1700 Irving Park Road, Chicago, Illinois.

CORTISONE-LIKE DRUGS STOP CHILDHOOD KILLER

Cortisone-like drugs are now turning the tide of battle against nephrosis, the childhood killer that used to claim 50% of its victims.

A three-year study of the drugs on 30 youngsters at the Children's Hospital of Philadelphia here has shown that the adrenal steroids can cut the death rate down to 20%.

Nephrosis is an acquired degenerative disease of the kidneys which occurs mostly in children. The cause is still unknown and up until the steroids came into use in the early 1950's there was little that could be done for the victims.

Now, with hormone treatment, improvement can sometimes be noticed within two weeks.

NEW ELECTRONIC DEVICE THREE WAYS BETTER THAN TRANSISTOR

A new discovery in electronics called the "spacistor" may well revolutionize present electronics devices and techniques much like transistors did vacuum tubes five years ago, when they ushered in the "era of miniaturization" in electronics components. The development of the new device was announced in a paper presented before a joint meeting of the Institute of Radio Engineers and the American Institute of Electrical Engineers.

The "spacistors," as they are called, are no larger than the tiny transistors. One type, pictured alongside an ordinary pin, can be seen to be only about "four pin-heads long and one pin-head wide."

Like vacuum tubes and transistors, the purpose of the new device is to boost the power of weak electric signals, that is, to "amplify" them.

U. S. ARMY HAS BATTERY THAT CAN BE WORN AS VEST

The U.S. Army has a battery that can be worn as a vest.

The flexible battery is designed to power a soldier's portable radio receiver and transmitter, particularly in cold regions, where a conventional battery's lifespan is very short.

It is made of two panels each containing a number of dry cells spaced and insulated from each other, but connected to make up the battery itself. The dry cells are heat-sealed in plastic and mounted on the vestlike garment. Each panel can be detached and replaced with a new one.

NEW ENZYMES CLOSE TO IDEAL BURN TREATMENT

An enzyme taken from the juice of a fig tree now speeds the treatment of burned human skin, one of mankind's most painful and dangerous injuries.

Named ficin, the enzyme literally dissolves away the damaged tissue and can completely clean a third-degree burn in three to five days.

It has been successfully used on over 300 burn patients during the last three years.

The process of clearing away the burned tissue is called debridement and must be done as soon after the injury as possible so that the damaged area will be ready for skin grafts.

The enzyme is applied to the burned area either as a paste or solution and works best on the most severe burns. It does the job by dissolving the damaged skin protein and can debride a third-degree burn faster than a deep second-degree burn.

With only partially damaged tissue, the enzyme treatment takes up to 12 days.

Ficin is the best of 25 or 30 enzymes which have been tried experimentally in the past few years but the hope is to find one which works even faster.

School Science *and* Mathematics

will keep you in touch with the most recent advances in scientific knowledge and teaching methods.

Classroom helps and special teaching devices for difficult topics are regular features. The Problem Department gives inspiration and extra activities for superior students.

The most progressive teachers in schools and colleges all over the world are regular readers and many of them are frequent contributors to this Journal.

School Science and Mathematics
P.O. Box 408, Oak Park, Ill.

teach ELECTRICITY and ELECTRONICS *easily, more effectively* with

CROW

INSTRUCTION EQUIPMENT

Crow equipment permits teachers without comprehensive technical training to cover Basic Electricity through Advanced Electronics. Shows abstract principles in action, makes electricity an exciting adventure in learning. Priced within the budget of every school. Write for bulletin giving full details.

UNIVERSAL SCIENTIFIC COMPANY, INC. | Vincennes, Indiana

Chemistry's Latest Advances are Treated in

the Second Revised Edition of

LIVING CHEMISTRY

by Ahrens, Bush and Easley

Clear and interesting treatment of such matters as nuclear energy, new industrial uses of chemistry, new drugs, new dentrifrices, air-conditioning and refrigeration, photography, fabrics and dyes, petroleum and synthetic rubber, etc. Covers all the basic principles of chemistry. Richly illustrated. Workbook, teachers' manual, key.

Ask for Descriptive Circular

GINN AND COMPANY

Sales Offices: New York 11, Chicago 6, Atlanta 3, Dallas 1, Columbus 16, Palo Alto, Toronto 7.
Home Office: Boston

— LIPPINCOTT ANSWERS YOUR NEEDS —

On the high school level, our workbook listing includes BIOLOGY, CHEMISTRY, GENERAL SCIENCE, and PHYSICS. Each book is designed for use with any leading text of its field; all feature accompanying Teachers' Manuals and tests.

On the elementary level, SCIENCE FOR MODERN LIVING WORKBOOKS, by Victor C. Smith, are destined to become a leader for content, color and adaptability. Books 1-3 and Manuals available now; Books 4-6 and Manuals ready in 1958.

J. B. LIPPINCOTT COMPANY

Chicago Philadelphia Atlanta Dallas Toronto

CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS, INC.

APPLICATION FOR MEMBERSHIP

Date .....19.....

I hereby apply for membership in the Central Association of Science and Mathematics Teachers, Inc., and inclose $3.50 for annual membership dues, which includes one year's subscription to SCHOOL SCIENCE AND MATHEMATICS. I will receive nine issues of this journal, none being published in July, August or September. (Subscriptions beginning with January issue expire with December; with October issue expire with June.)

Begin: JANUARY ☐ Begin: OCTOBER ☐

(PLEASE PRINT)

Name .....
Last Name First Name

School Address .....
Name of School City State

Home Address .....
Street City Postal Zone State

Journals will be sent to home address unless otherwise requested

Underline Section in which enrollment is desired: *Biology, Chemistry, Elementary Science, Elementary Mathematics, General Science, Geography, Mathematics, Physics* .....

Mail this application with $3.50 (Canada $3.75, Foreign $4.00) to Central Association of Science and Mathematics Teachers, Inc., P.O. Box 408, Oak Park, Ill.

PLEASE CHECK IF YOU FORMERLY WERE A MEMBER ☐

TEACH IN CHICAGO

SALARY SCHEDULE—$4000 to $8000—in 13 Steps
CREDIT FOR EXPERIENCE
For Full Information Write
BOARD OF EXAMINERS
Room 242 228 N. LaSalle Street Chicago 1, Illinois

ADVERTISING PAYS

•

When your ads are run regularly in SCHOOL SCIENCE and MATHEMATICS
Our Rates are low. Compare them with other educational journals.
We reach the buyers of scientific apparatus and books.

•

Reserve space and send copy for our next issue to
SCHOOL SCIENCE AND MATHEMATICS Box 408, Oak Park, Ill.
Ray C. Soliday, Bus. Mgr.

Secondary Mathematics

—A COMPLETE PROGRAM TO FACILITATE TEACHING—TO ENHANCE LEARNING

"Excellent innovations . . . well conceived ideas . . . will appeal to conservative and forward-looking teachers."

Smith-Lankford **ALGEBRA ONE** and **TWO**
Smith-Lankford **PLANE** and **SOLID GEOMETRY**
Smith-Hanson **TRIGONOMETRY**

World Book Company

YONKERS-ON-HUDSON, New York 2126 Prairie Avenue, Chicago 16

Please Mention *School Science and Mathematics* when answering Advertisements

School Science and Mathematics

—a journal devoted to the improvement of teaching of the sciences and mathematics at all grade levels.
—nine issues per year, reaching readers during each of the usual school months, September through May.
—owned by The Central Association of Science and Mathematics Teachers, Inc., edited and managed by teachers.

SUBSCRIPTIONS—$4.50 per year, nine issues, school year or calendar year. Foreign $5.00. No numbers published for July, August, September.

BACK NUMBERS—available for purchase, more recent issues 75¢ per copy prepaid with order. Write for prices on complete annual volumes or sets. Consult annual index in December issues, or Educational Index to Periodicals, for listings of articles.

The following interesting topics are discussed in issues of 1956:

Science Stories for Children—Magnetism—Demonstrations in Physics—Remedial Arithmetic—Elementary School Science Library—Recent Research in Science Education—Informal Geometry—Nomographs—The Circles Relating to a Triangle—The Relative Effectiveness of Group Instruction—Parallelograms with Integer Sides and Diagonals.

USEFUL REPRINTS—(orders for reprints must be prepaid)

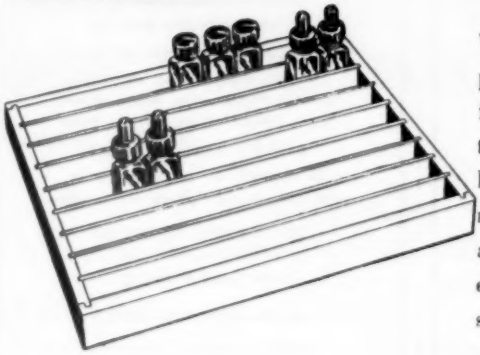
Atomic Energy: A Science Assembly Lecture, Illustrated	.25
Mock Trial of B versus A—A play for the Mathematics Club	.30
How Much? A Mathematics Playlet	.25
100 Topics in Mathematics—for Programs or Recreation	.25
Poison War Gases	.20
New Emphases in Mathematical Education, with bibliographies	.25
Mathematics Problems From Atomic Science	.25
The Mathematics of Gambling	.25
Optical Illusions: for high school mathematics	.25
Computations With Approximate Numbers	.35
The Radical Dream—A Mathematical Play for Puppets	.20
How Water Serves Man. A teaching unit	.20
Won by a Nose. A Chemistry play	.25
Radioactive Isotopes: A Science Assembly Lecture, illustrated	.25
Kem: Two Games for Chemistry Classes	.15
Modern Periodic Arrangements of the Elements; illustrated	.25
Ion Visits the Realm of Air. A Play	.25
The King of Plants. A play for science clubs	.25
Three Families of Great Scientists: dramatized	.30
Some Lessons About Bees. A 32-page booklet; illustrated	.20
The Triumph of Science. A play for auditorium programs	.25
In Quest of Truth. A play in two parts	.25
A Student's Approach to Mechanics	.25
Apparatus for Demonstrating the Fundamentals of Radio	.20
Youth Opens the Door to Cancer Control, bibliographies	.25
Vitalizing Chemistry Teaching. A Unit on the Halogens	.15
A Scientific Assembly Program, Wonders of Science	.30
What Is Scientific Method?	.20
Elementary School Science Library	.20
Projection Demonstrations in General Science	.20
Atomic Energy—A Play in Three Scenes	.30
Motion Pictures for Elementary Science	.25

SCHOOL SCIENCE AND MATHEMATICS

Price $4.50—Foreign $5.00

P.O. Box 408 Oak Park, Ill.

WACO SEMI-MICRO APPARATUS



Wilkens-Anderson has earned its place as specialist in Apparatus for Semi-Micro chemistry . . . through the years authors have looked to us for the pieces which made their Semi-Micro text books and manuals so successful and easy to use! Seven text books now show WACO S-M apparatus!

WEISBRUCH-WACO Reagent Bottle Tray

According to SEMI-MICRO LABORATORY EXERCISES In High School Chemistry, by Fred T. Weisbruch.

Holds complete set of student reagents in WACO Reagent Bottles, in rows. Made of hard maple and birch, a permanent piece used many years. Size 12 x 10½ x 1¼ inches. Without bottles, $3.25 each . . . in dozen lots $2.95 each. Specify Cat. No. 10490-1.

HAND FINISHED SPATULAS

Perfectly shaped spatulas for Semi Micro Qualitative and Organic Chemistry. W A C O Monel Spatulas are nicely balanced, permanent pieces. Glassware breakage is reduced, as scratching is eliminated. No. 10115 WACO Monel Spatulas 175 mm. long. Slightly dished tip to hold crystals. $3.10 per doz., $24.00 per 100.

At the price, W A C O Spatulas class as "Non-Returnables!"

Write today for FREE brochures . . .

- Complete Catalogue WACO Semimicro Apparatus, Vol. 1.
- Listing of S-M Apparatus according to SEMI-MICRO LABORATORY EXERCISES In High School Chemistry, Fred T. Weisbruch.

LABORATORY SUPPLIES AND CHEMICALS

WILKENS-ANDERSON CO.

4525 W. DIVISION ST. CHICAGO 51, ILLINOIS

APTITUDE AND
ACHIEVEMENT TESTS
for
SCIENCE AND
MATHEMATICS

General Science	General Mathematics
Biology	Arithmetic
Chemistry	Algebra
Physics	Geometry

Standardized—Quick-Scoring

Write for catalog and prices

BUREAU OF EDUCATIONAL RESEARCH AND SERVICE
EXTENSION DIVISION, STATE UNIVERSITY OF IOWA, IOWA CITY

MATHEMATICS CONTESTS
Information sent on request
STUDENT SLIDE RULES
FIELD WORK IN MATHEMATICS
By Shuster and Bedford
Other special books to enrich mathematics teaching
FIELD WORK INSTRUMENTS
Transits, Plane Tables, Alidades
Sextants, Hypsometers, Angle Mirrors
Tapes, Leveling Rods, Ranging Poles
GROVE'S MOTO-MATH SET
To illustrate all plane figures in High School and College Mathematics
MULTI-MODEL GEOMETRIC CONSTRUCTION SET
For Solid Geometry
VISUAL AIDS AND MODELS
Send for literature and Prices
YODER INSTRUMENTS
The Mathematics House Since 1930
East Palestine, Ohio

$MnO_2 \rightarrow Mn_3$ TiO_2 CuO MgO

INVITATION TO TEACHERS OF GENERAL SCIENCE

Join the thousands of other teachers who are using the free and proven materials published by the Manufacturing Chemists' Association, Inc. for the use of teachers and students at the junior high school level.

Following announcement of their availability in the fall of 1956, these materials, prepared in consultation with science educators, have been requested for use in more than 5,500 schools.

Featuring 10 easy-to-do and practical student experiments with clear instructions and illustrations.

A recent evaluation study shows that almost 90 percent of the teachers adopting the program describe it as helpful to them and to their students.

Free Each school participating in this program for the first time is offered without charge the following quantities of materials:

- 1 "Superstition to Supersonics"—Teacher Book
- 1 Pictorial Teacher Chart on the World of Science
- 35 "Superstition to Supersonics"—Student Book
- 35 "Frontiersman of the Future"—Vocational Guidance Book

Address all requests for descriptive booklet, order form, sample examination sets, or for bulk shipments to:

DR. WILLIAM E. CHACE, DIRECTOR OF EDUCATION
MANUFACTURING CHEMISTS' ASSOCIATION, INC.
1625 EYE ST., N.W., WASHINGTON 6, D. C.

HgO FeO $2PbO+O_2$ Fe_2O_3 $+O_2$

Please Mention *School Science and Mathematics* when answering Advertisements

Mathematics Books for Today's Needs

ALGEBRA: ITS BIG IDEAS AND BASIC SKILLS, Books I and II

Second Edition

Aiken Henderson and Pingry

Organized around the big ideas and basic skills of algebra, making it more understandable and meaningful to students. Optional topics and problems for superior students; many new problems to fix and apply skills. Two colors throughout, with the second color used to teach. 160 new drawings, adding a visual dimension to ideas. Exercises to help pupils discover principles. Self tests to check progress. Tests and Teacher's Key. Solutions Manual for Book I.

USING MATHEMATICS 7-8-9

Henderson and Pingry

Makes mathematics interesting and challenging to 7th, 8th, and 9th grade pupils. Problems interest boys and girls, farm and city pupils. Easy reading level. Color drawings and cartoons provide motivation and illustrate principles. Self-teaching methods help pupils to discover principles for themselves. The meaningful approach makes clear the reason *why* as well as the how. Teacher's Manuals and Keys. Teacher's Editions of Books 7 and 8. Problems Workbooks in preparation.

Write for descriptive circulars

McGRAW-HILL BOOK COMPANY

New York 36 Chicago 30 Dallas 2 San Francisco 4

Please Mention *School Science and Mathematics* when answering Advertisements

High visibility...

Lifetime accuracy...

CENCO®
Mercury Barometer

Here's a practical mercury barometer that's easy to read . . . accurate . . . capable of fine adjustment . . . and built for years of dependable service. The glass tube is completely enclosed in a hexagonal brass tube with metric and English scales attached. Constructed as prescribed by the U.S. Weather Bureau to conform to correction charts established by them. This is an unusually fine instrument at a remarkably low price.

Order today for prompt delivery

No. 76890 Cenco Mercury Barometer for altitudes 0 to 4000 ft..... each, **$53.00**

No. 76891 Cenco Mercury Barometer for altitudes from 1500 to 10,000 feet.....each, **$62.50**

No. 76892 Metal Barometer Mounting with conversion table..... each, **$7.50**

cenco
The most complete line of scientific instruments and laboratory supplies in the world
RS

CENTRAL SCIENTIFIC COMPANY
General Offices and Factory—7 1 8-L **Irving Park Road • Chicago 13, Illinois**
Branches and Warehouses—Mountainside, N. J. • Boston • Birmingham
Central Scientific Co. of California—Santa Clara • Los Angeles
Refinery Supply Company—Tulsa • Houston
Central Scientific Co. of Canada, Ltd.—Toronto • Montreal • Vancouver • Ottawa